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Z3801A GPS Receiver

User's Guide

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This guide describes how to install and operate the Z3801A GPS Receiver. The information in this guide applies to instruments having the number prefix listed below, unless accompanied by a "Manual Updating Changes" package indicating otherwise.

SERIAL PREFIX NUMBER: 3506A and above

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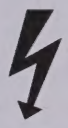
Warning Symbols That May Be Used In This Book

Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.



Indicates hazardous voltages.

Indicates earth (ground) terminal.

or

Indicates terminal is connected to chassis when such connection is not apparent.

Indicates Alternating current.

Indicates Direct current.

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Guide Organization

Table of Contents

In This Guide (this preface) introduces you to the User's Guide, and provides general information on the GPS Receiver.

Chapter 1, "**Getting Started**," is a quick-start chapter that introduces you to the GPS Receiver with a brief overview of the Receiver's indicators and connectors. Installation and power-up instructions, and a section that provides sample commands to start operating the Receiver are provided to get you familiar and comfortable with operating the Receiver.

Chapter 2, "**Features and Functions**," provides information on Receiver's features and functions, connecting to computers, and problem solving (that is, a section titled "In Case of a Problem").

Chapter 3, "**Using the Receiver Status Screen**," provides information on how to use the Receiver Status screen and the SatStat program. An illustrated foldout of the Receiver Status screen, which is a comprehensive summary of key operation conditions and settings, is provided at the end of this chapter.

Chapter 4, "**Command Listing and Status Information**," briefly lists all of the commands that can be used to operate the Receiver and provides Receiver status and error message information.

Chapter 5, "**Specifications Summary**," lists the Z3801A specifications and characteristics.

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Description of the Z3801A GPS Receiver

The Z3801A GPS Receiver provides highly accurate time and frequency outputs that can be used for synchronizing CDMA Cellular Land Network wireless base stations.

The Receiver provides highly accurate timing. If a satellite signal is lost, the Receiver automatically switches to holdover mode, which ensures system synchronization for up to 24 hours with reduced accuracy.

The Z3801A has the following rear-panel Input/Output connectors:

- an I/O Port 1 25-pin female rectangular D subminiature connector (This connector provides two 1 PPS time outputs, two 10 MHz frequency outputs, and an RS-422 serial interface port).
- 10 MHz output BNC connector
- an Antenna N-type connector
- Power input jack

The front panel contains six Light-Emitting-Diode (LED) indicators to indicate that power has been applied (**Power**), the module has tracked and locked on to one or more GPS satellites (**GPS Lock**), the GPS system is operating in holdover mode (**Holdover**), and an error or invalid condition exists due to system fault or reduced accuracy of the outputs (**Alarm**), and two LEDs illuminated under user-defined conditions (**Enabled**, **Active**).

The Z3801A has no front panel display or keypad entry. Information is remotely entered into and retrieved from the Z3801A using customer-supplied DCE (Digital Communications Equipment) connected to the rear-panel 25-pin RS-422 serial interface port.

Options

- Rack Mount Tray 29.5 inch (750-millimeter)
- CV90-14271-1 GPS Receiver Unit, +27 Vdc, beige, single output
- CV90-14271-2 GPS Receiver Unit, --54 Vdc, beige, single output
- CV90-14271-11 GPS Receiver Unit, -+27 Vdc, gray, single output
- CV90-14271-12 GPS Receiver Unit, --54 Vdc, gray, single output
- CV90-15357-1 GPS Receiver Unit, +27 Vdc, beige, single output
- CV90-15357-2 GPS Receiver Unit, --54 Vdc, beige, single output
- CV90-14805-1 Shelf, Dual GPS Receiver Mounting, beige
- CV90-14805-11 Shelf, Dual GPS Receiver Mounting, gray

Accessories Supplied and Available

Accessories Supplied

SatStat Program (59551-13401)

Accessories Available

For more details on available GPS accessories refer to the *Designing Your GPS Antenna System Configuration Guide* (P/N 5964-9068E). Refer to the subsections titled "Recommended Antenna Cable Assemblies" and "Antenna Cable Length Delay" in Chapter 2 of this guide for more cable information.

- CV90-14807 Coaxial cables
- CE90-14806 Antenna, GPS Receiver
- CE90-15275 Lightning Arrestor, GPS Receiver
- CE90-15276 Line Amplifier, GPS Receiver
- 58504A GPS Antenna Assembly
- 58510A GPS Antenna Environmental Cover and Ground Plane (optional use with the 58504A GPS Antenna Assembly)
- 58513A GPS Antenna Assembly[1]
- 58505B Lightning Arrester
- 58509A Antenna Line Amplifier (recommended for distances greater than 175ft./53.3 meters for RG-213 cable; 200 ft/61 meters for LMR cable)

- 58518A RG-213 Antenna Cable Assembly (3.3 to 164.0 ft, or 1 to 50 meters)—TNC-to-N connectors
- 58519A RG-213 Interconnect Cable Assembly (3.3 to 164.0 ft, or 1 to 50 meters)—N-to-N connectors
- 58520A LMR 400[2] Antenna Cable Assembly (3.3 to 360.8 ft, or 1 to 110 meters)—TNC-to-N connectors
- 58521A LMR 400[2] Interconnect Cable Assembly (3.3 to 360.8 ft, or 1 to 110 meters)—N-to-N connectors
- 58518AA[3] RG-213 TNC-N Antenna Cable Assembly (3.3 to 164.0 ft, or 1 to 50 meters) without connectors attached
- 58519AA[3] RG-213 N-N Interconnect Cable Assembly (3.3 to 164.0 ft, or 1 to 50 meters)—without connectors attached
- 58520AA[3] LMR 4002 TNC-N Antenna Cable Assembly (3.3 to 360.8 ft, or 1 to 110 meters)—without connectors attached
- 58521AA[3] LMR 4002 N-N Interconnect Cable Assembly (3.3 to 360.8 ft, or 1 to 110 meters)—without connectors attached

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[1] The 58513A is a completely assembled unit, which includes the 58504A Antenna, a 4-foot cable, the 58510A environmental cover and ground plane, and a 1-foot stainless steel mounting mast.

[2] LMR 400 cables are low-loss, less flexible than RG-213, but are very good coaxial cables.

[3] These cables do not have the connectors attached. A connector kit is supplied.

Manuals

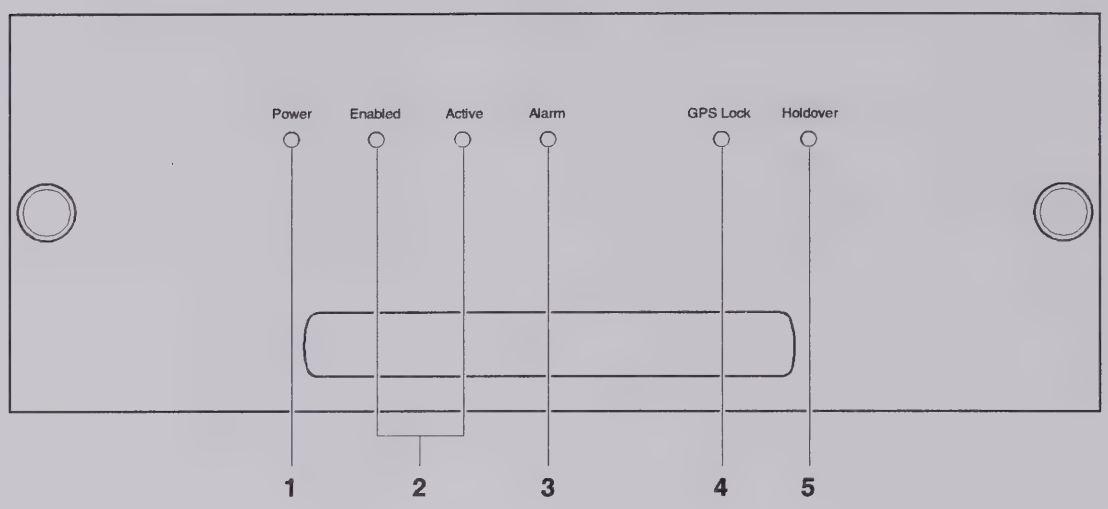
Supplied Manual

Z3801A User's Guide (this guide), P/N Z3801-01

1

Getting Started

Z3801A Front Panel at a Glance



1 When the **Power** indicator is illuminated, it indicates that the proper input power is supplied to the Receiver.

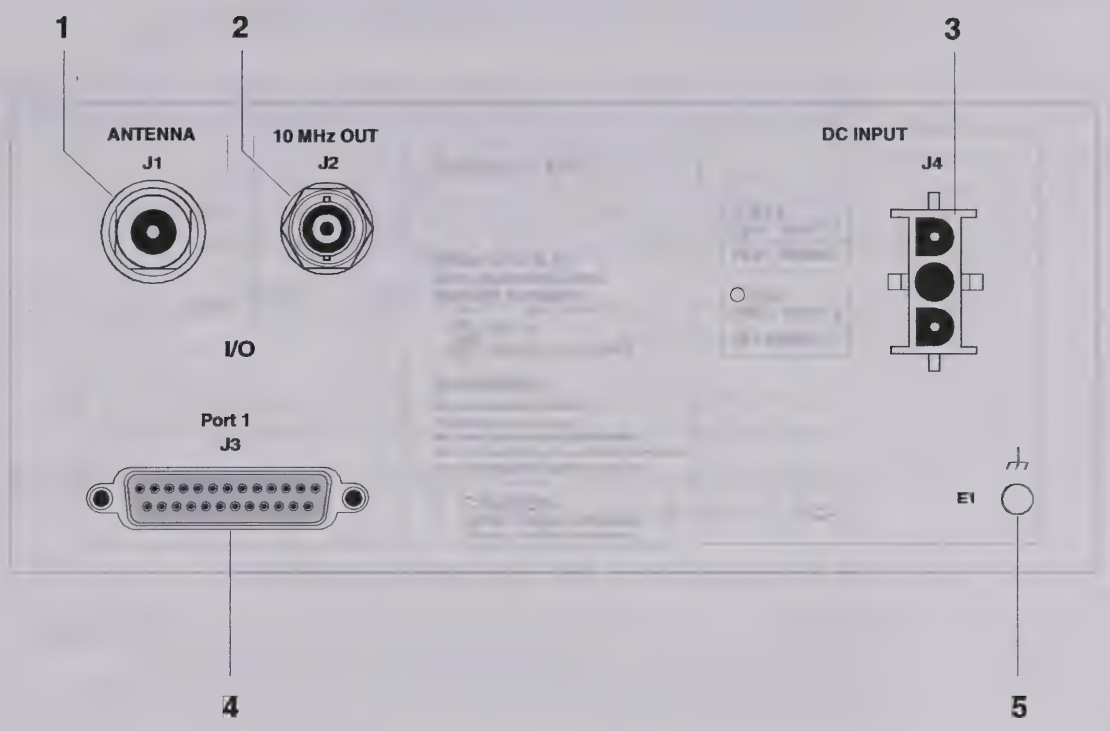
2 User-definable indicators labeled **Enabled** and **Active**. These can be turned on through the RS-422 port.

3 When the **Alarm** indicator is illuminated, it indicates that the receiver has detected an internal condition that requires attention.

4 When the **GPS Lock** indicator is illuminated, it indicates that the Receiver is receiving the GPS signal and is locked on one or more satellite(s).

5 When the **Holdover** indicator is illuminated, it indicates that the Receiver is NOT locked to the GPS signal. The Receiver is keeping time based on the internal reference oscillator signal. The internal reference oscillator will determine the accuracy of the 1 PPS signal and the 10 MHz reference output. (See specification for Accuracy in Holdover in Chapter 5, "Specifications Summary," in this guide.)

Z3801A Rear Panel at a Glance



1 **ANTENNA J1** N-type (female) connector.

2 **10 MHz OUT J2** BNC (female) output connector for user-specific applications.

3 **DC INPUT J4** power connector.

4 **I/O Port 1 J3** 25-pin female D Subminiature RS-422 serial interface port for remote control, monitoring, and retrieving of the unit's memory data. This port also provides two 1 PPS time outputs, and two 10 MHz frequency outputs.

5 **E1** Ground stud provides a low impedance ground for safety and systems grounding. WARNING: Ground stud must be connected to Safety Earth Ground.

Preparing the GPS Receiver for Use

To Assemble and Install the Antenna System

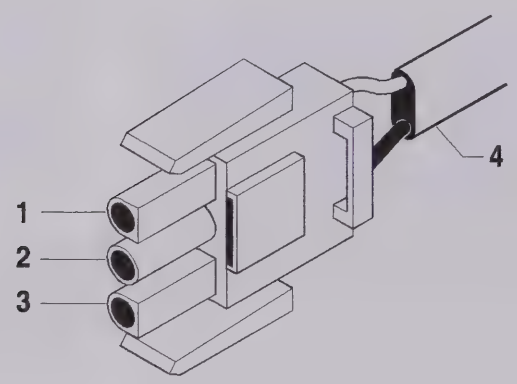
CABLE CONSIDERATIONS. When using the antenna cables with the GPS Receiver, you should observe certain precautions. Consult your local electrical and building ordinance codes on how to install RG-213 cables (58518A/519A) or LMR 400 cables (58520A/521A). Certain codes might require you to put the cables inside a conduit, or to use cables made with a non-toxic fire retardant insulation.

To assist you with installing your GPS antenna system, refer to the following documents:

- Information Notes that provide installation procedures for the applicable GPS antenna and accessories that you purchase.
- The subsection titled "ANTENNA Input" in Chapter 2, "Features and Functions," of this guide.

To Assemble the DC Power Connector

1 Note that you will have to assemble your own dc power cable using 18 AWG connecting wires and a three-pin AMP Universal MATE-N-LOKII® (female) connector plug (shown in Figure 1-1).



1 dc supply (+)

2 Not used

3 dc supply (-)

4 Cable wires

Figure 1-1. Three-Pin Plug Pinouts (Front View)

2 From the rear of the plug, connect the supply-side wire of the external power supply or battery to pin 1 of the plug. Connect the external

battery's return (ground) wire to pin 3. Use the rear-panel **E1** ground stud to connect the GPS Receiver chassis to a system ground.

3 Observing the correct polarity, attach the other ends of the wires to a proper dc power source to operate the Receiver.

NOTE *Do not apply power to the Receiver unless a fully operational antenna system is connected to the rear-panel ANTENNA J1 connector. Power applied with no antenna input can initiate an extended search process that may increase time to reach GPS lock. You can halt the extended search by disconnecting and reconnecting (cycling) the external dc supply (you may need to leave power disconnected for greater than five seconds).*

Powering Up the Receiver

Overview of the Power-Up Procedure (What to Expect)

When you power up the GPS Receiver for the first time, you should expect it to run through the following sequence:

- goes through internal diagnostics and all front-panel lights flash,
- acquires and tracks four satellites,
- computes the Receiver's position,
- locks to the 1 PPS (one pulse-per-second) time standard provided by GPS, and
- begins steady-state operation, acting as a source of timing and synchronization information derived from the GPS standard.

Elapsed time for each step will vary, depending largely on how many satellites your antenna is able to "see" when you power up. If many satellites are visible when you power up, the Receiver will take at least 8 minutes and at most 25 minutes to calculate its position from the constellation of satellites overhead. The derived position will be improved over a period of time by further averaging. When the **GPS Lock** indicator lights, the basic functionality of the Receiver is available; however, optimal performance is delivered later.

To Power Up the Receiver

1 Connect the antenna system to the rear-panel **ANTENNA J1** Type-N connector of the Receiver as described in the instructions given in the subsection titled "To Assemble and Install the Antenna System" on page 1-4 of this chapter.

NOTE

Although connecting the GPS Receiver to a terminal or computer isn't necessary for it to attain GPS lock, the terminal is needed for you to observe the progress of the Receiver or to configure alarms.

2 Connect the GPS Receiver to your system DCE device (Digital Communications Equipment) via the rear-panel **I/O Port 1 J3** RS-422 port using an appropriate (*customer supplied*) system interface cable as shown in Figure 1-2.

NOTE *Do not apply power to the Receiver unless a fully operational antenna system is connected to the rear-panel ANTENNA J1 connector. Power applied with no antenna input can initiate an extended search process that may increase time to reach GPS lock. You can halt the extended search by disconnecting and reconnecting (cycling) the external dc supply (you may need to leave power disconnected for greater than five seconds).*

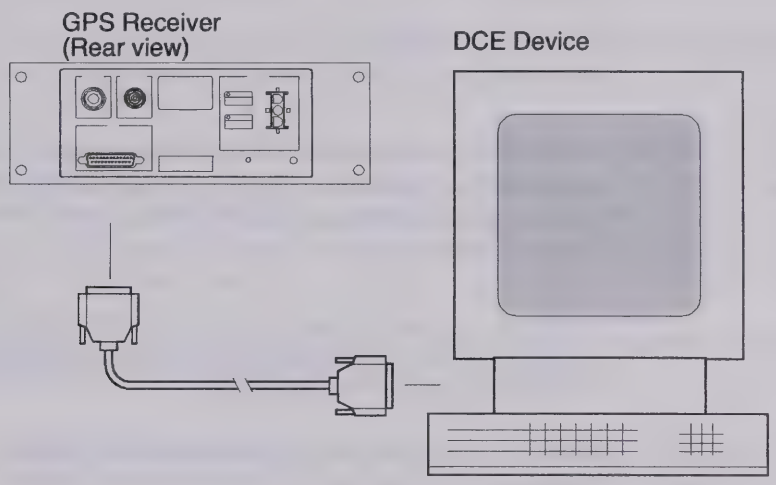


Figure 1-2. Connecting the GPS Receiver to a DCE Device (DTE-to-DCE Interface cable is customer supplied)

3 Turn your DCE device (or PC equipped with a correctly wired RS-422 serial-port connector) on.

You will need to run a terminal emulation program on your DCE device in order to communicate via the RS-422 serial port. Most PCs contain a terminal emulation program, especially PCs with Windows application. If your PC does not contain a terminal emulation program, purchase one of the following programs: PROCOMM PLUS (DATASTORM Technologies, Inc.®), PROCOMM PLUS for Windows, Cross Talk (Hayes®), or any other terminal emulation program. (**Note:** Symmetricom is not endorsing any of these products.)

Another option to purchasing and installing a terminal emulation program is to use the SatStat Program. See the section titled "Installing the Automated SatStat Program for Continual Status Updates" on page 1-11 for installation and operating information.

4 Set the RS-422 port of your DCE device (or PC) to match the following values:

Pace:	NONE
Baud Rate:	19200
Parity:	Odd
Data Bits:	7/char
Start Bits:	1
Stop Bits:	1

NOTE

The RS-422 port configurations of the Receiver and the DCE device/PC must be the same for communications between the two. Thus, for this power-up procedure, set your DCE device/PC to match the default values listed above.

5 Apply the proper power source to the rear-panel **Power** input jack of the Receiver. (See the appropriate subsection titled "To Assemble the DC Power Connector" on page 1-4)

The following sequence of events occurs after power is applied to the Receiver.

a. Only the front-panel **Power** indicator lights.

b. After a moment, the Receiver runs through its self-test diagnostics as indicated by the flashing front-panel indicators.

c. After the self test is completed, just the **Power** indicator remains lit.

If the **Alarm** indicator lights, a failure may have occurred during the self test. Refer to Table 4-2 in Chapter 4, "Command Listing and Status Information," of this guide for information on the Alarm capability.

d. The Receiver begins to search the sky for all available satellites.

e. From the DCE device keyboard, type

:SYSTEM:STATUS? and press Enter (or Return).

Confirm that the **scpi>** prompt is displayed after pressing Return. If no prompt or an error-number prompt (**E-xxx>**) is displayed, then try typing the command again.

The computer displays the status screen as shown in the sample status screen in Figure 1-3.

You must re-enter the :SYSTEM:STATUS? command each time you want an updated status screen.

NOTE

You have been provided a Windows program called SatStat, which provides *continual status updates* of the GPS Receiver's status screen. If you are using an RS-422 equipped PC, it must have Windows installed to operate the user interface application. The application is easy to install and operate.

See the section titled "Installing the Automated SatStat Program for Continual Status Updates" on page 1 in this guide.

f. When four or more satellites are tracked as will be indicated in the status screen, automatic position computation is initiated.

g. Finally, the Receiver goes into steady-state operation (which requires one satellite) and the **GPS Lock** indicator lights, indicating the Receiver has locked on to the GPS signal.

After the initial powerup, the Receiver is set for basic operation. That is, the Receiver operating parameters are set to their powerup default values or states.

If you need to customize the Receiver operation, see the section titled "Customizing the Receiver Operation" on page 1-13 for a list of key things you may want to perform to customize the operating parameters of the Receiver.

```
---------------------------- Receiver Status ----------------------------

SYNCHRONIZATION ........................  [ Outputs Valid/Reduced Accuracy ]
SmartClock Mode ___________________________ Reference Outputs______________
>> Locked to GPS: stabilizing frequency... TFOM     3
   Recovery                                FFOM     0
   Holdover                                1PPS TI +20 ns relative to GPS
   Power-up                                HOLD THR 1.000 us

ACQUISITION ....................................... [GPS 1PPS CLK Accurate]
Satellite Status ___________________________ Time ________________________
Tracking: 5       Not Tracking: 4           GPS      03:56:44   1994 DEC 01
PRN  El  Az  SS   PRN  El  Az               1PPS CLK Synchronized to GPS Time
  2  70 337 134    12  11 292               ANT DLY  120 ns
  7  46 188 117    16  24 243               Position ________________________
 15  33  82  54   *26  Acq..                MODE     Survey: 57.3% complete
 19  28 113  29    31  -- ---
 27  65  91 128                             AVG LAT  N  37:19:31.330
                   *attempting to track     AVG LON  W 121:59:50.468
ELEV MASK  10                               AVG HGT          +54.89 m  (MSL)
HEALTH MONITOR ........................................................ [ OK ]
Self Test: OK | Int Pwr: OK Oven Pwr: OK    OCXO: OK   EFC: OK   GPS Rcv: OK
```

Figure 1-3. Sample Status Screen

To Understand the Receiver Status Screen Data

One of the key indicators on the screen is the ACQUISITION status indicator. It shows *"GPS 1 PPS Valid"* as soon as satellite information is sufficient.

Refer to Chapter 3, "Using the Receiver Status Screen," in this guide for a tutorial on how to use the status screen (shown in Figure 1-3). A reference section that defines the different data indicated in the status screen is also provided in Chapter 3.

Installing the Automated SatStat Program for Continual Status Updates

This Windows application provides continual status updates of the Receiver Status screen. Your PC must be equipped with a correctly wired (See Table 2-3 in Chapter 2.) RS-422 serial-port adapter and have Windows installed to operate the user interface application. The application is easy to install and operate.

1 Insert the SatStat disk in drive A.

2 From the File menu in either the Program Manager or File Manager, choose Run.

3 Type **a:setup**, and press Enter (or Return). The SatStat Setup screen will appear, and installation will proceed.

4 Once the program is installed, you can start it by double-clicking the **SatStat** icon that was created during the installation.

5 You should establish communication with the GPS Receiver. This requires connection from the DCE device (Digital Communications Equipment) via the rear-panel **I/O Port 1 J3** RS-422 port using an appropriate (*customer supplied*) system interface cable. Assuming you've got the cable attached to make this connection, you may want to check the settings.

   a. Select **CommPort**, then choose **Settings**.

   The Communication Settings dialog box is displayed. Unless someone has reprogrammed the CommPort settings on the GPS Receiver, these settings are probably OK. *The one setting that is likely to need changing is the Com Port. The application defaults it to Com1, but the serial port on your PC may be assigned to a different Com Port. Select the appropriate setting. If you are unsure, Com1 will be your best bet (worst case, you can cycle through all of them until it works).*

   b. If you made any changes on this Settings form, select **OK**, otherwise you can just **Cancel**.

Operating the Automated SatStat Program

1 Select **CommPort**, then choose **Port Open**.

The main form of the Receiver Status screen is displayed. The program will send some commands to the GPS Receiver and then the main form should begin to periodically update every few seconds. If you are getting screen updates, proceed to the next step. Otherwise, something is wrong with your CommPort settings or perhaps the physical connection between your PC and the Receiver.

If you need to control the Receiver or query for the status of a setting of the Receiver, use the "Control & Query" form (this form will usually be stacked beneath the main form). To activate this form, click anywhere on it. Select **Control** (or **Query**), then choose the type of control (or query) you want. This will pull down a list of control (or query) functions that you can choose from, and the corresponding command will be displayed. To send the command, click on **Send Cmd**. Hence, with the Control & Query form you can control the Receiver without knowing the command or query.

More information about the Windows program is provided in the "Getting Started" Help file.

2 Refer to the section titled "Using and Reading the Receiver Status Screen" in Chapter 3, "Using the Receiver Status Screen," of this guide for a tutorial and demonstration of what to look for when viewing the status screen.

Customizing the Receiver Operation

Here are some key things you might want to perform to customize the Receiver operation:

- Execute a system preset if you've found the Receiver in an unknown or questionable operating state.
- Make the Receiver survey if it wasn't already surveying.
- Set the antenna delay.
- Set the elevation mask angle.
- Set the time zone.

See the section titled "Using Commands to Control Key Functions (Examples)" on the following page for more information.

Using Commands to Control Key Functions (Examples)

The operation of the GPS Receiver is designed to be as automatic as possible. However, there are several situations where serial interface control is required. The tasks described here are those most commonly encountered.

For each task in this section, you can use either a terminal emulation program or the SatStat program to issue the selected commands. Additional information about the commands is provided in Chapter 4, "Command Listing and Status Information," of this guide.

To Perform Basic Installation and Simple Customizing

After connecting the Receiver to the antenna, power source, DCE device RS-422 port, and after the self test is completed, you may want to complete installation using one or more of the capabilities described below.

If required, restore all of the Receiver's internal settings to their factory shipment values by invoking a system preset.

After executing the system preset, the Receiver will begin normal operation: it will acquire GPS signals, determine the date, time, and position automatically, bring the reference oscillator ovens to a stable operating temperature, lock the reference oscillator and its output to 10 MHz, and synchronize the 1 PPS output to UTC.

Settings affected by system preset are listed in Chapter 4, "Command Listing and Status Information," of this guide under the :SYSTEM:PRESET command definition.

The Receiver is preset using the command:

```
:SYSTEM:PRESET
```

Note that system preset should be performed only when necessary.

Initiate "surveying", an automatic determination of the Receiver's antenna position.

When "position survey" is invoked, the Receiver is set to ascertain the position of its antenna automatically. This survey is important; correct antenna position data is required for the Receiver to deliver specified performance.

The Receiver uses data from orbiting satellites to survey; hence, the antenna must be installed and operational for the survey to work. However, if you have a limited view of the sky, you can complete basic installation, then read forward to the section titled "To Install With a Limited View of the Sky, To Bypass Position Survey Operation" on page 1-16 for a means of overriding the survey operation and entering position data directly.

The survey is an iterative process. The Receiver transits to "Position Hold" when a usable position has been obtained.

Set the Receiver to survey using command:

:PTIME:GPSYSTEM:POSITION:SURVEY ONCE

Set the Receiver to compensate for the length of the antenna cable.

The Receiver can be custom-configured to compensate for the length of the antenna cable. The phase of the Receiver's internal clock is therefore offset from the GPS standard by the number of nanoseconds of delay introduced through the antenna cable. The amount of error is typically on the order of a few hundred nanoseconds. Should you decide to correct for this error, Table 2-1A and Table 2-1B in Chapter 2, "Features and Functions," of this guide provides typical corrections for standard antenna cable lengths.

Set the Receiver to compensate for antenna cable delay using command:

:PTIME:GPSYSTEM:ADELAY *<seconds>*

or

:PTIME:GPSYSTEM:ADELAY *<nanoseconds>* NS

It is normal to observe that the Receiver momentarily goes into holdover after any change in antenna delay.

Set the Receiver to exclude satellites which appear below a specified elevation angle.

At the factory, and whenever the Receiver is preset, the Receiver is set to seek satellites visible from zenith down to 10 degrees above the horizon—down to an "elevation mask angle" of 10 degrees. The factory elevation mask angle setting is intended to provide a full view of the sky. The Receiver can be custom-configured to use a different elevation mask angle.

Set the Receiver elevation mask angle using the command:

:PTIME:GPSYSTEM:EMANGLE *<degrees>*

Set the Receiver to display local time rather than UTC time.

Set the offset from UTC time to local time using the command:

:PTIME:TZONE *<hours>, <minutes>*

To Install With a Limited View of the Sky, To Bypass Position Survey Operation

In order to reach steady-state operation, the Receiver must know the position of the antenna. The Receiver is able to collect enough information from four satellites to compute this position. The "position survey operation" takes in data from the satellites, iterating until the antenna position is known to the required precision. The Receiver will automatically use its position survey operation on powerup and :SYSTEM:PRESET.

Alternatively, if the antenna position is already known to seconds of arc, and the Receiver cannot see enough satellites, you may manually enter antenna position as shown in the following text.

NOTE

An incorrect value for the position will confuse the Receiver, and will degrade the timing information accuracy or even prevent tracking any satellites.

Set the Receiver antenna position using the command format shown below (for clarity, an example is provided rather than a complex description.):

:PTIM:GPS:POS N,37,19,32.5,W,121,59,51.2,40.12

Using Commands to Control Key Functions (Examples)

Set the latitude, longitude, and height parameters to represent the latitude (in degrees, minutes, seconds), longitude (in degrees, minutes, seconds), and altitude in meters above mean sea level (MSL). (Note: if you know the position to this accuracy, the desired position is of the antenna rather than the Receiver.)

NOTE

For faster acquisition following repair, or power failure you may want to write down the position after the Receiver has completed its survey.

2

Features and Functions

Chapter Contents

You will find that this section makes it easy to look up all the details about a particular feature of the Z3801A GPS Receiver. This chapter provides inputs, outputs, indicators, terminal and computer connections, operating concepts (GPS lock and holdover), and problem-solving information.

This chapter is organized as follows:

- Inputs page 2-3
  - ANTENNA Input page 2-3
  - DC INPUT J4 Power Jack page 2-6
- Outputs page 2-7
  - 10 MHz OUT J2 Output page 2-7
  - 10 MHz Outputs—via I/O Port 1 J3 page 2-7
  - 1 PPS (One Pulse Per Second) Outputs— via I/O Port 1 J3 page 2-7
  - RS-422 Serial Port, I/O Port 1 J3 page 2-8
- Indicators page 2-9
  - Power Indicator page 2-9
  - Enabled/Active Indicator page 2-9
  - Alarm Indicator page 2-9
  - GPS Lock Indicator page 2-9
  - Holdover Indicator page 2-9
- Connecting to a Computer page 2-10
- Operating Concepts page 2-11
  - General page 2-11
  - Holdover Description page 2-11
- In Case of a Problem page 2-12

Inputs

ANTENNA Input

The N-type (female) **ANTENNA** connector allows you to connect the 58504A or 58513A Antenna Assembly. The antenna assemblies are "active" antennas; a "passive" antenna will not work with the Receiver.

Integral to the antenna assembly is a low noise amplifier (LNA) that is provided for Receiver operation with antenna cable lengths up to 378 feet (115.2 meters) for LMR 400 cables or 175 feet[1] (53.3 meters) for RG-213 cables. The single coax cable is used to provide signals from the antenna to the Receiver and to supply a dc voltage to the LNA. For longer antenna feed runs, an additional amplifier (58509A Antenna Line Amplifier) is required to compensate for lengths greater than 378 feet (115.2 meters) or 175 feet (53.3 meters).
An environmental cover that shields the antenna from wind, rain, and snow, and a ground plane that prevents problems with reflected signals is available as the 58510A—or combined in the 58513A.

Refer to Chapter 1, "Getting Started," in this guide for information on the components of the antenna system and installation instructions.

Recommended Antenna Cable Assemblies

There are two types of cable assemblies that we recommend you use to connect your antenna system: LMR 400 or RG-213 (Belden® 8267).

The following paragraphs describes when and how many line amplifiers are required with the LMR 400 and RG-213 cables.

[1] One hundred and seventy-five feet includes the sum total of all of the cables used to connect the antenna to the (such as the cable between the antenna and line amplifier, the cable between the line amplifier and lightning arrester, and the cable between the lightning arrester and the).

LMR 400 Cable Line Amplifier Requirements

If cable length between GPS Receiver and antenna is:

- Less than 115 meters (377 feet), no line amplifier is necessary.
- More than 115 meters (377 feet) and less than 240 meters (787 feet), you need 1 line amplifier.
- More than 240 meters (787 feet) and less than 360 meters (1181 feet), you need 2 line amplifiers.
- More than 360 meters (1181 feet), contact sales/support for assistance.

RG-213 Cable Line Amplifier Requirements

If cable length between GPS Receiver and antenna is:

- Less than 53 meters (174 feet), no line amplifier is necessary.
- More than 53 meters (174 feet) and less than 105 meters (345 feet), you need 1 line amplifier.
- More than 105 meters (345 feet) and less than 158 meters (518 feet), you need 2 line amplifiers.
- More than 158 meters (518 feet), contact sales/support for assistance.

Antenna Cable Length Delay

The RG 213 propagation delay is 1.54 nanoseconds per foot (5.05 ns/meter). The LMR 400 propagation delay is 1.2 nanoseconds per foot (3.93 µs/meter). Given these delay values per foot you can calculate the delay for your cable length.

Tables 2-1A and 2-1B list the delay values that you need to use with the :GPSYSTEM:REFERENCE:ADELAY *<seconds>* command for the available the cable assemblies.

Table 2-1A. Delay Values for the 58518A/519A and 58518AA/519AA RG-213 Antenna Cables

Cable Option	Length	RG 213 or Belden 8267 Antenna Delay Value
001	3.3 ft (1m)	5.0 nanoseconds
002	6.7 ft (2 m)	10.3 nanoseconds
005	16.4 ft (5 m)	25.2 nanoseconds
010	32.8 ft (10 m)	50.5 nanoseconds
015	49.2 ft (15 m)	75.7 nanoseconds
030	98.4 ft (30 m)	151.5 nanoseconds
050	164.0 ft (50 m)	252.5 nanoseconds

The nominal delay value is labeled on the cables. Refer to the *Designing Your GPS Antenna System Configuration Guide* (P/N 5964-9068E for more information.)

Table 2-1B. Delay Values for the 58520A/521A and 58520AA/521A LMR 400 Antenna Cables

Cable Option	Length	LMR 400 Antenna Delay Value
001	3.3 ft (1m)	3.9 nanoseconds
002	6.7 ft (2 m)	8.0 nanoseconds
005	16.4 ft (5 m)	19.6 nanoseconds
010	32.8 ft (10 m)	39.3 nanoseconds
015	49.2 ft (15 m)	59.0 nanoseconds
030	98.4 ft (30 m)	118.0 nanoseconds
060	196.8 ft (60 m)	236.1 nanoseconds
110	360.8 ft. (110 m)	432.9 nanoseconds

The nominal delay value is labeled on the cables. Refer to the *Designing Your GPS Antenna System Configuration Guide* (P/N 5964-9068E for more information.)

DC INPUT J4 Power Jack

The **DC INPUT J4** jack allows you to connect a BTS 19.5-30.0 Vdc or BSC -38 to -60 Vdc power source to drive the Receiver.

Table 2-2 lists the input jack pin assignments. This jack is used for DC power only.

Table 2-2. DC INPUT J4 Power Connections

Pin Number	Signal Name
1	dc supply (+)
3	dc return (–)

See Figure 1-1 in Chapter 1, "Getting Started," in this guide for an illustration of the AMP Universal MATE-N-LOKII® dc power jack.

Outputs

10 MHz OUT J2 Output

This is a 10 MHz output reference signal traceable to UTC (USNO) that can be used for synchronizing CDMA test equipment.

10 MHz Outputs—via I/O Port 1 J3

Two additional 10 MHz synchronization signals are available through the I/O Port 1 J3 connector. Refer to Table 2-3 for signal characteristics and connector pin assignment information.

1 PPS (One Pulse Per Second) Outputs—via I/O Port 1 J3

The Receiver outputs two highly accurate 1 PPS time standard outputs for user-specific synchronization applications. Refer to Table 2-3 for signal characteristics and connector pin assignment information.

In the GPS locked mode, the Receiver outputs a 1 PPS signal derived from the internal oscillator, which is locked and traceable back to Coordinated Universal Time (UTC) as determined by GPS. In the absence of GPS, the 1 PPS signal will continue to exist, but the oscillator will go into a holdover mode in which the SmartClock™ algorithm will compensate for the instabilities in the oscillator. In the holdover mode, the timing 1 PPS accuracy will degrade as the holdover time increases.

RS-422 Serial Port, I/O Port 1 J3

The 25-pin female D Subminiature (DB-25) connector located on the rear panel provides RS-422 serial communications capability.

This can be used by connecting a DCE device with an RS-422 serial interface port (wired to interface with the receiver's I/O port as listed in Table 2-3) and suitable terminal emulation software, then sending the correct commands for transmitting or retrieving data. You can customize the Receiver on installation, to change the Receiver's operating characteristics, retrieve Receiver state information, and clear the stored data. The pins used are described in Table 2-3.

Table 2-3. Rear-Panel RS-422 Serial Port/10 MHz/1PPS Pin Assignments

*Pin Number	Input/Output	Description
1	Cable Shield	
2 (A), 14 (B)	Output	Transmit Data (TxD)—GPS Receiver output RS-422 (per RS-530)
3 (A), 16 (B)	Input	Receive Data (RxD)—GPS Receiver input RS-422 (per RS-530)
7	———	Signal Ground (SG)
15 12	10 MHz_1- 10 MHz_1+	Differential pseudo ECL 10 MHz output
11 24	10 MHz_2- 10 MHz_2+	Differential pseudo ECL 10 MHz output
17 9	1 PPS/_1- 1 PPS/_1+-	Differential pseudo ECL 1 PPS output
8 21	1 PPS/_2- 1 PPS/_2+	Differential pseudo ECL 1 PPS output

*All other pins, no connection.

Indicators

Power Indicator

This indicator lights when the input power is supplied to the Receiver.

Enabled/Active Indicator

These user definable indicators light when turned on through the RS-422 serial interface port.

Alarm Indicator

The Receiver lights this indicator to indicate it has detected an internal condition that requires attention.

Refer to Table 4-2 in Chapter 4, "Command Listing and Status Information" of this guide for information on Alarm capability.

GPS Lock Indicator

This indicator lights when the Receiver is tracking satellites and phase-locked its internal reference to the reference time derived from satellite data. This indicator will go off whenever the above condition is not met, which would typically occur when satellite tracking is lost or while the Receiver is powering up.

The principal Receiver setting that can affect this indication is manual selection of reference oscillator holdover operation.

Holdover Indicator

The Receiver lights this indicator to show that GPS lock has been lost and the Receiver is in holdover mode. It only lights it the Receiver has been locked once; it will never light until the Receiver has been locked once. While in holdover, the internal reference oscillator will be adjusted by SmartClock™ technology .

NOTE

If the Holdover indicator lights before the Receiver has been locked 24 hours, then the Receiver has not had sufficient time to learn the characteristics of the internal reference oscillator. In this case, the specification for Timing Accuracy during holdover may not be met. This specification applies only after the Receiver has had sufficient stable operation time.

Refer to the subsection titled "Holdover Description" on page 2-11 in this chapter for more information.

Connecting to a Computer

To connect the GPS Receiver to a computer, you must have an appropriately wired RS-422 interface cable (*customer supplied*). Refer to Table 2-3 for rear-panel I/O Port 1 J3 pin assignments and signal characteristic information.

The interface cable must also have the proper connector on each end and the internal wiring must be correct. The GPS Receiver is considered the Data Terminal Equipment (DTE) for this interface.

The Z3801A rear-panel serial interface port has a fixed configuration as described in Chapter 1 of this guide on page 1-3.

Operating Concepts

General

The time required to acquire GPS lock as described in the following paragraph can vary significantly depending on your local conditions. In general, we strongly recommends that your antenna and cables be set up in accordance with the information provided in this guide prior to using the output signals of the Receiver to ensure they are valid.

Acquiring lock does not mean that the Receiver is fully operational and meeting all specifications. It just means that the Receiver has detected enough satellites to start its survey mode to determine its precise location. An internal measurement FFOM (Frequency Figure of Merit) becomes 0 when the internal loops reach their proper time constants, indicating that the output frequency and 1 PPS signals are now fully operational and meeting their specifications. Under the worst conditions, the Receiver may take up to 24 hours to achieve FFOM = 0. FFOM can be monitored in the Reference Outputs quadrant of the Receiver Status screen (see Figure 3-1 in Chapter 3, "Using the Receiver Status Screen," of this guide). Also, using the appropriate SCPI query command will provide FFOM value (refer to Chapter 4, "Command Listing and Status Information," in this guide for specifics).

The Receiver is designed to automatically detect and acquire satellites in order to begin providing precise frequency and time information. Until such acquisition is complete and the instrument is locked with FFOM = 0, the signals produced on the rear panel are not precise.

Holdover Description

If the GPS signal is interrupted, the Receiver enters an intelligent holdover mode that uses SmartClock® technology. SmartClock takes over control of the quartz oscillator that has been steered to the GPS reference during locked operation. SmartClock predicts the performance of the quartz oscillator based on the information gathered during the "learning period" (locked to GPS). Corrections are automatically issued over time, keeping the performance of the quartz oscillator as close as possible to the performance achieved while locked to the GPS reference signal.

Holdover frequency is maintained to better than $<1 \times 10^{-9}$ per day. The time specifications 1 µs locked, and 7µs unlocked for 24 hours. When the GPS reference signal is restored, the Receiver automatically switches back to normal mode of operation.

In Case of a Problem

Hours after powerup, Receiver not establishing GPS lock

SYMPTOM Date, time, and position still show power-up defaults, or these parameters are incorrect.

Receiver Position Mode = Survey.

Receiver cycling from one set of satellites to another.

No satellites consistently tracked.

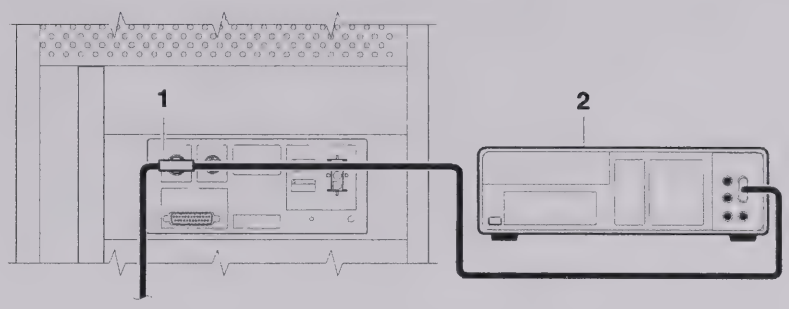
Solution Check antenna:

- Verify antenna has an unobstructed view of the sky—antenna is not under or beside an impervious object.
- Verify antenna is connected.
- Verify antenna is connected properly:
  - cable run not too long.
  - cable with antenna attached neither shorted nor open.
- Verify antenna is being properly driven—*Hint:*

  (1) connect Tee-connector to Receiver's rear-panel **ANTENNA J1** input; connect antenna cable to one end of Tee. Measure a little less than +5 Volts from the other end of the Tee using a digital voltmeter (DVM) as shown in Figure 2-1. If your reading is a lot less than +5 Volts, you will have to determine if the line amplifier or lightning arrester is at fault by using conventional troubleshooting isolation techniques. If the line amplifier and lightning arrester are good, then the antenna may be faulty.

  (2) If the Receiver +5 Volts is okay, check +5 Volts at the antenna end of the cable with a voltmeter connected between the center conductor and shell. If insufficient voltage is present, it may indicate that the shield of the cable is not making adequate contact to one of the cable connectors.
- After the antenna connection has been verified, cycle power on the Receiver to facilitate rapid recovery from the fault.

NOTE Remove the Tee connector and restore antenna connection as loading of the Tee connector will prevent proper reception of the GPS signal by the antenna.



1 Tee-connector **2** DVM

Figure 2-1. Measuring +5 Volts Across Antenna Input

SYMPTOM Same as previous symptoms, except Receiver Position Mode = Hold.

SOLUTION Enable SURVEY mode using specified command.

Receiver not maintaining GPS lock

SYMPTOM Position data incorrect.

SOLUTION Survey to obtain correct position,

or

Correct position data using specified command.

SYMPTOM Position data correct.

Sufficient satellites in view.

No satellites tracked.

SOLUTION If candidate satellites are marked "Ignore" on status screen, disable the feature which ignores satellites.

If candidate satellites are below the mask angle specified on Receiver Status screen, reset the elevation mask angle. Default is 10 degrees—all satellites between the horizon and 10 degrees of the horizon are masked.

3

Using the Receiver Status Screen

Chapter Contents

This chapter provides a tutorial section on how to use the Receiver Status screen, a comprehensive reference information section, and an illustrated foldout of the Receiver Status screen, which is a comprehensive summary of key operation conditions and settings.

This chapter is organized as follows:

- Using and Reading the Receiver Status Screen — page 3-3
  - Tutorial on Using the Status Screen to Interface With the Receiver — page 3-4
  - Demonstration of Holdover Operation — page 3-8
- Receiver Status Screen Data — page 3-11
  - SYNCHRONIZATION Section of the Status Screen — page 3-12
  - ACQUISITION Section of the Status Screen — page 3-14
  - HEALTH MONITOR Section of the Screen — page 3-18
- The Receiver Status Screen at a Glance — page 3-20

Using and Reading the Receiver Status Screen

The Receiver Status screen can be accessed when the GPS Receiver is connected to a properly configured terminal or PC. There are two ways to access and use the Receiver Status screen:

- By installing a commercially available terminal emulation program, connecting the GPS receiver to a DCE device (Digital Communications Equipment) via the rear-panel **I/O Port 1 J3** RS-422 port using an appropriate (*customer supplied*) system interface cable, and manually sending the :SYSTEM:STATUS? query. (Refer to Chapter 1, "Getting Started," in this guide.)
- By installing and operating the SatStat program which automatically generates continual status screen updates, and connecting the GPS Receiver to a PC via via the rear-panel **I/O Port 1 J3** RS-422 port using an appropriate (*customer supplied*) system interface cable. (Refer to the sections titled "Installing the Automated HP SatStat Program for Continual Status Updates" and "Operating the Automated HP SatStat Program" in Chapter 1, "Getting Started," of this guide for details on installation.)

The following tutorial demonstrates how you can use the Receiver Status screen to observe GPS Receiver operation. The tutorial uses the manual (:SYSTEM:STATUS?) method.

Tutorial on Using the Status Screen to Interface With the Receiver

Type :SYSTEM:STATUS? at the **scpi>** prompt.

An initial power-up screen is displayed, which is similar to the demonstration screen shown in Figure 3-1. The first data that you should look at is in the SYNCHRONIZATION area of the screen. It is telling you that it is in the Power-up state as indicated by the >> marker. That is, the Receiver has just been put on line.

```
---------------------------- Receiver Status ----------------------------
SYNCHRONIZATION ........................................ [ Outputs Invalid ]
SmartClock Mode  ____________________________  Reference Outputs_____________
   Locked                                      TFOM     9            FFOM     3
   Recovery                                    1PPS TI  --
   Holdover                                    HOLD THR 1.000 us
>> Power-up:GPS acquisition                   Holdover Uncertainty___________
                                               Predict  --

ACQUISITION ............................................ [GPS 1PPS Invalid]
Satellite Status  ___________________________  Time ___________________________
Tracking: 0       Not Tracking: 6              UTC      12:00:00[?] 01 JAN 1996
                   PRN  El  Az                 GPS 1PPS Invalid:not tracking
                    *1  -- ---                 ANT DLY  0 ns
                    *6  -- ---                 Position ______________________
                    *9  -- ---                 MODE     Survey: 0% complete
                   *14  -- ---                          Suspended:Track <4 sats
                   *22  -- ---                 INIT LAT N   0:00:00.000
                   *24  -- ---                 INIT LON W   0:00:00.000
ELEV MASK 10 deg  *attempting to track         INIT HGT          0 m (MSL)
HEALTH MONITOR ........................................................ [ OK ]
Self Test: OK  Int Pwr: OK   Oven Pwr: OK    OCXO: OK   EFC: OK   GPS Rcv: OK
```

Figure 3-1. Receiver Status Screen at Powerup

The ACQUISITION area of the screen is telling you that no satellites have been tracked. The identification numbers of several satellites appear in the Not Tracking column. The asterisk next to the satellite identification number, or pseudorandom noise code (PRN), indicates the Receiver is attempting to track it.

The current time and date are shown in the Time quadrant of the ACQUISITION area. The default power-up setting, indicated by [?], is corrected when the first satellite is tracked. Since the Receiver is not tracking any satellites, the GPS 1 PPS reference signal is invalid.

An accurate position is necessary to derive precise time from GPS. The Position quadrant indicates that the Receiver is in survey mode, which uses GPS to determine the position of the GPS antenna. This process has not yet started, since position calculations can be performed only while tracking four or more satellites. INIT LAT, INIT LON, and INIT HGT are the initial estimate of the true position. These coordinates are refined by the survey process. The Receiver uses this position and the time-of-day to select satellites to track. Therefore, you can reduce satellite acquisition time by specifying an close approximation of position and time.

Now, let's send the :SYSTEM:STATUS? query again to see what kind of progress the Receiver has made.

You can now see that the Receiver is tracking several satellites as shown in Figure 3-2. The process of acquiring and tracking satellites is described in the following paragraphs.

```
---------------------------- Receiver Status ----------------------------

SYNCHRONIZATION ........................... [ Outputs Valid/Reduced Accuracy ]
SmartClock Mode  ____________________________ Reference Outputs_______________
>> Locked to GPS: stabilizing frequency      TFOM     6            FFOM     1
   Recovery                                  1PPS TI +71 ns relative to GPS
   Holdover                                  HOLD THR 1.000 us
   Power-up                                  Holdover Uncertainty ___________
                                             Predict  --
ACQUISITION ..............................................[GPS 1PPS Valid]
Satellite Status  ___________________________ Time ____________________________
Tracking: 5        Not Tracking: 4            UTC      17:56:44   31 Jan 1996
PRN  El  Az  SS    PRN  El  Az                GPS 1PPS  Synchronized to UTC
  2  70 337 134      9  11 292                ANT DLY  0 ns
  7  46 188 117     16  24 243                Position ______________________
 15  33  82  54    *26  Acq..                 MODE     Survey: 1.2%   complete
 19  28 113  29     31  -- ---
 22  65  91 128                               AVG LAT  N  37:19:34.746
                                              AVG LON  W 121:59:50.502
ELEV MASK 10 deg  *attempting to track        AVG HGT           +34.14 m  (MSL)
HEALTH MONITOR ............................................................ [ OK ]
Self Test: OK  Int Pwr: OK  Oven Pwr: OK     OCXO: OK  EFC: OK  GPS Rcv: OK
```

Figure 3-2. Receiver Status Screen Displaying Initial Satellite Acquisition

An asterisk (*) next to the PRN of a satellite in the Not Tracking column indicates the Receiver is attempting to track it. The elevation (El) and azimuth (Az) angles of the satellite are indicated. Acq . or Acq.. tell you that the Receiver is attempting to track that satellite. One dot after the Acq indicator shows that the Receiver is attempting to acquire its signal, and two dots indicate impending lock. Eventually, you will see the satellite move from the Not Tracking column, which shows the satellite PRN, the elevation angle of the satellite in the sky (90° being zenith), the azimuth angle (number of degrees bearing from true north), and the signal strength (SS). A good signal strength is a number above 20, which would be efficient for the Receiver to operate. Numbers below 20, suggest intermittent tracking of the satellite or no tracking; check your antenna system should this be the case.

As indicated by the demonstration screen in Figure 3-2, the Receiver is now surveying for position. It is tracking four satellites which is the minimum number that must be tracked to determine position. As you can see, the Position MODE line indicates survey is 1.2% complete. A complete survey would take two hours during which four satellites or more are continuously tracked.

Also, you can see the initial (estimated) position has been replaced with a computed position, which the Receiver continuous to refine until it gets a very accurate position. The status screen indicates that a computed position is being used by displaying the averaged latitude, and longitude height (AVG LAT, AVG LON, and AVG HGT).

If the position were not precise, GPS timing information would be inaccurate by an amount corresponding to the error in the computed position. An error in the computed position of the antenna translates into an error in the derived time and will compromise the Receiver's ability to be a timing source.

Let's consider a case where four satellites are not visible at powerup because of a poor antenna location, such as an "urban canyon" (located between tall city buildings). If accurate position is known from a Geodetic survey of that site, it can be programmed with the position command, thereby bypassing the survey operation. This is useful when four satellites cannot be tracked for an extended period of time.

Let's send the :SYSTEM:STATUS? query again to observe the current status of the Receiver.

The updated demonstration status screen in Figure 3-3 indicates that the position survey is now 5.4% complete. Thus, the survey task is beginning to iterate toward an accurate position. In the Time quadrant, the UTC time is now correct. The date is correct, and the GPS reference signal is synchronized to UTC.

```
---------------------------- Receiver Status ----------------------------

SYNCHRONIZATION ..............................[ Outputs Valid/Reduced Accuracy ]
SmartClock Mode ____________________________  Reference Outputs______________
>> Locked to GPS: stabilizing frequency       TFOM     4            FFOM     1
   Recovery                                  1PPS TI +20 ns relative to GPS
   Holdover                                  HOLD THR 1.000 us
   Power-up                                  Holdrover Uncertainty __________
                                             Predict 432.0 us/initial 24 hrs

ACQUISITION ..................................................[GPS 1PPS Valid]
Satellite Status ___________________________ Time ___________________________
Tracking: 6        Not Tracking: 1           UTC      18:47:07   31 Jan 1996
PRN  El  Az  SS    PRN  El  Az               GPS 1PPS  Synchronized to UTC
  2  70 301  82     16  13 258               ANT DLY  0 ns
  7  35 186  71                              Position _______________________
 19  40 102  61                              MODE     Survey: 5.4%   complete
 22  71  60  84
 26  19 317  54                              AVG LAT  N  37:19:34.937
 31  16  41  52                              AVG LON  W 121:59:50.457
ELEV MASK 10 deg                             AVG HGT           +67.94 m  (MSL)
HEALTH MONITOR ...............................................................[ OK ]
Self Test: OK  Int Pwr: OK   Oven Pwr: OK    OCXO: OK   EFC: OK   GPS Rcv: OK
```

Figure 3-3. Receiver Status Screen Displaying Progress Towards Steady-State Operation

In the SYNCHRONIZATION area, the >> marker is pointed at the Locked to GPS line, indicating that the Receiver is locked to GPS and stabilizing the frequency of its oscillator. This means that the Receiver has phase-locked its oscillator to the 1 PPS reference signal provided by GPS, but it is not at its final, or most stable, state. The Receiver is locked and the front-panel **GPS Lock** LED is illuminated.

For users without the command interface (PC/Terminal emulator connected to the Receiver), the illuminated **GPS Lock** LED is probably the first indication that after powerup that the Receiver is moving towards a stable state.

With the command interface and status screen, you can get more detailed information. For example, you can read the reference outputs quality indicators in the Reference Outputs area of the status screen. These are the Time Figure of Merit (TFOM) and Frequency Figure of Merit (FFOM) indicators. As shown in Figure 3-3, the TFOM is 4 and the FFOM is 1. These values will eventually decrease towards the ultimate values that represent steady-state performance. Refer to the subsection titled "Reference Outputs," on page 3-13 in this chapter for more information about TFOM and FFOM.

Also indicated is a prediction of the accuracy of the Receiver should it go into holdover operation.

Demonstration of Holdover Operation

CAUTION

The Receiver typically reaches stable state 24 hours after powerup, and it will learn best if its experiences no holdover in the first 24 hours. Therefore, the holdover demonstration in the following paragraphs will compromise the Receiver's ability to learn the characteristics of its internal reference oscillator. For the purpose of education only, you will be shown how to initiate a holdover.

A user should never initiate holdover during the first 24 hours while the Receiver is learning its internal oscillator characteristics. The Receiver should maintain GPS lock during this time because it is using the GPS signal to discipline the oscillator. It will learn what the oscillator drift characteristics are relative to the GPS signal. It will learn how the oscillator ages, and the software will learn how to compensate for that aging.

Thus, it is recommended that the Receiver is always kept locked to GPS during the first 24 hours.

For demonstration purposes, and since the Receiver has been powered up for a while, let's put the Receiver into holdover by simply removing the antenna connection. (*Note that holdover also can be manually initiated by sending the* SYNCHRONIZATION:HOLDOVER:INITIATE *command; however, for this demonstration, disconnect the antenna cable.*) The following will occur :

- The front-panel **Holdover** LED will illuminate, and
- after sending the :SYSTEM:STATUS? query again, a screen similar to Figure 3-4 should appear.

Let's send the :SYSTEM:STATUS? query. Figure 3-4 should appear.

```
---------------------------- Receiver Status ----------------------------
SYNCHRONIZATION ........................... [ Outputs Valid/Reduced Accuracy ]
SmartClock Mode  ________________________   Reference Outputs______________
   Locked to GPS                            TFOM     3            FFOM     2
   Recovery                                 1PPS TI  --
>> Holdover: GPS 1PPS invalid               HOLD THR 1.000 us
   Power-up                                 Holdover Uncertainty  ________
                Holdover Duration: 0m 14s   Predict 432.0 us/initial 24 hrs
                                            Present 1.0 us
ACQUISITION ...................................................[GPS 1PPS Invalid]
Satellite Status ________________________   Time ___________________________
Tracking: 0       Not Tracking: 7           UTC      20:56:14   31 Jan 1996
                  PRN  El  Az  PRN  El  Az  GPS 1PPS  Inaccurate: not tracking
                  *2   71 316  *31  12  29  ANT DLY  0 ns
                  *7   41 186               Position ________________________
                   15  11  86               MODE     Survey: 71.1% complete
                  *19  35 107
                  *22  68  78               LAT      N  37:19:32.472
                  *26  23 314               LON      W 121:59:51.784
ELEV MASK 10 deg  *attempting to track      HGT                +42.19 m  (MSL)
HEALTH MONITOR ..............................................................[ OK ]
Self Test: OK  Int Pwr: OK  Oven Pwr: OK    OCXO: OK  EFC: OK  GPS Rcv: OK
```

Figure 3-4. Receiver Status Screen Displaying Holdover Operation

In the SYNCHRONIZATION area, you can see that the Receiver has gone into holdover as indicated by >> marker that is pointing at the Holdover line. The status screen indicates that the reason the Receiver is in holdover is because the GPS 1 PPS reference signal is invalid.

You would expect this since the antenna has been disconnected.

The status screen shows, instantaneously, loss of the GPS signal. As you can see on the screen, all of the satellites in the Tracking column moved into the Not Tracking column.

The status screen in Figure 3-4 shows that the Receiver has been in holdover operation for 14 seconds.

If the Receiver SmartClock had had enough time to learn the internal oscillator characteristics (24 hours), the Receiver status screen would show that the Receiver went into holdover, and the Receiver's outputs were maintained during holdover by the SmartClock.

When the GPS antenna is re-connected and the GPS signal has been re-acquired, the Receiver has the ability to recover from holdover by itself. The SYNCHRONIZATION area of the screen will show the >> marker pointing at the Recovery line (and then eventually at the Locked to GPS line), the GPS Lock LED will illuminate, and the screen will look similar to Figure 3-5.

```
---------------------------- Receiver Status ----------------------------

SYNCHRONIZATION ..............................[ Outputs Valid/Reduced Accuracy ]
SmartClock Mode  ____________________________  Reference Outputs______________
>> Locked to GPS: Stabilizing frequency        TFOM     3            FFOM     1
   Recovery                                    1PPS TI +10.6 ns relative to GPS
   Holdover                                    HOLD THR 1.000 us
   Power-up                                    Holdover Uncertainty___________
                                               Predict 432.0 us/initial 24 hrs

ACQUISITION ..................................................[GPS 1PPS Valid]
Satellite Status _____________________________ Time ___________________________
Tracking: 6       Not Tracking: 0              UTC      20:59:28   31 Jan 1996
PRN  El  Az  SS                                GPS 1PPS Synchronized to UTC
  2  71 317  80                                ANT DLY  0 ns
  7  34 185  73                                Position ______________________
 19  41 101  64                                MODE     Survey: 71.4% complete
 22  67  80  87
 26  24 312  55                                LAT      N  37:19:32.486
 31  12  27  49                                LON      W 121:59:52.082
ELEV MASK 10 deg                               HGT               +40.06 m  (MSL)
HEALTH MONITOR ...............................................................[ OK ]
Self Test: OK  Int Pwr: OK  Oven Pwr: OK   OCXO: OK  EFC: OK  GPS Rcv: OK
```

Figure 3-5. Receiver Status Screen Following Recovery from Holdover Operation

You can see the Receiver has recovered from holdover almost immediately and it has returned to locked operation.

Receiver Status Screen Data

This section defines the data displayed in the Receiver Status screen, shown in Figure 3-6.

```
---------------------------- Receiver Status ----------------------------
SYNCHRONIZATION ........................................ [ Outputs Valid ]
SmartClock Mode  ________________________   Reference Outputs ____________
>> Locked to GPS                            TFOM     3          FFOM     0
   Recovery                                 1PPS TI +7.2 ns relative to GPS
   Holdover                                 HOLD THR 1.000 us
   Power-up                                 Holdover Uncertainty  ________
                                            Predict  49.0 us/initial 24 hrs

ACQUISITION ..............................................[GPS 1PPS Valid]
Tracking: 6 ___    Not Tracking: 1 _______
PRN  El  Az  SS    PRN  El  Az              Time ______ +1 leap second pending
 2   49 243 168     14  11  82              UTC       23:59:59    31 Dec 1995
 16  24 282 125                             GPS 1PPS  Synchronized to UTC
 18  38 154 132                             ANT DLY   120 ns
 19  65  52 168                             Position ____________________
 27  62 327 246                             MODE      Survey: 17.5% complete
 31  34  61 133
                                            AVG LAT  N  37:19:32.264
                                            AVG LON  W 121:59:52.112
ELEV MASK 10 deg                            AVG HGT          +41.86 m  (MSL)
HEALTH MONITOR ........................................................ [ OK ]
Self Test: OK  Int Pwr: OK  Oven Pwr: OK    OCXO: OK   EFC: OK   GPS Rcv: OK
```

Figure 3-6. Sample Status Screen

The status screen has three major sections:

- SYNCHRONIZATION
- ACQUISITION
- HEALTH MONITOR

The SYNCHRONIZATION section of the status screen shows how the GPS Receiver's SmartClock™ technology is progressing towards its objective, which is to synchronize the Receiver's oscillator to the 1 PPS reference signal produced by the Receiver's internal GPS Engine.

The ACQUISITION section of the status screen shows how the Receiver's internal GPS Engine is progressing towards its objective, which is to produce an accurate internal 1 PPS reference signal. It does so through tracking GPS satellites.

The HEALTH MONITOR section of the status screen summarizes the overall health of the product.

SYNCHRONIZATION Section of the Status Screen

SYNCHRONIZATION Summary Line

The **SYNCHRONIZATION** line in the screen summarizes the **SmartClock Status** and **Reference Outputs**. One of three SYNCHRONIZATION messages is shown:

Outputs Invalid	while the Receiver (unit) is warming up,
Outputs Valid/ Reduced Accuracy	while the unit is in holdover or is locked but has not achieved steady-state operation, or
Outputs Valid	while the unit is in steady-state operation.

SmartClock Mode

The SmartClock Mode area of the screen shows the four operating modes:

- Locked to GPS
- Recovery
- Holdover
- Power-up

As shown in the sample status screen in Figure 3-6, a >> symbol indicates the current operating mode.

Locked to GPS indicates that the Receiver is locked to GPS. The front-panel **GPS Lock** LED will be illuminated.

When *stabilizing frequency ...* is shown, the time output (1 PPS) signal is locked and can be used, but the frequency outputs (10 MHz) are not at their final or most stable state.

Recovery indicates that the Receiver is actively working to become locked to GPS. All conditions needed to proceed towards a lock have been met. Expect an eventual spontaneous transition to a lock (unless changing external conditions prevent this, such as loss of tracked satellites.)

Holdover indicates that the Receiver is waiting for conditions that are needed to allow the process of recovery from holdover to begin. Once these conditions are met, the Receiver will transition on its own to the recovery mode.

When the *GPS 1PPS CLK invalid* message follows the **Holdover** label, the internal GPS 1 PPS reference signal is inaccurate.

When the *manually initiated* message follows the **Holdover** label, the Receiver has been placed in holdover by the user. An explicit command is required to initiate an exit from manual holdover.

When the *1 PPS TI exceeds hold threshold* message follows the **Holdover** label, the phase difference between the 1 PPS time output signal and the internal GPS 1 PPS reference signal has exceeded the user-entered holdover threshold value.

When the *internal hardware problem* message follows the **Holdover** label, a measurement hardware error exists.

The *Holdover Duration* message indicates the duration that the Receiver has been operating in holdover (and recovery). Thus, this message gives you an assessment of the quality of the outputs. The longer the Receiver is in holdover the more degraded the outputs become.

Power-up indicates that the Receiver hasn't yet achieved GPS lock or acquired satellites since it has been powered up. The Receiver is measuring the internal reference oscillator's frequency and adjusting it to 10 MHz during this power-up period. Other queries can provide insight as to the cause if the Receiver is remaining in powerup longer than expected.

Reference Outputs

TFOM (Time Figure of Merit) indicates the *accuracy* of the Receiver's 1 PPS output. A low TFOM value indicates a more accurate output. In the sample screen of Figure 3-6, a value of 3 is displayed, meaning that the Time Error ranges from 100 to 1000 nanoseconds. The following table lists the TFOM values that could be displayed and the corresponding Time Error.

TFOM Value	Time Error (in nanoseconds)	TFOM Value	Time Error (in nanoseconds)
*0	less than 1	5	10^4–10^5
*1	1–10	6	10^5–10^6
*2	10–100	7	10^6–10^7
3	100–1000	8	10^7–10^8
4	10^3–10^4	9	greater than 10^8

* The TFOM values 0, 1, and 2 are not presently used in the Receiver. The Receiver will display TFOM values ranging from 9 to 3, which is consistent with the specified accuracies of each product.

FFOM (Frequency Figure of Merit) indicates the *stability* of the Receiver's 10 MHz output. The 10 MHz output is controlled by the SmartClock's Phase-Locked Loop (PLL). Thus, the FFOM value is determined by monitoring the status of the PLL.

In the sample screen of Figure 3-6, the 0 indicates that the SmartClock's PLL is stabilized. The following table lists and defines the FFOM values that could be displayed.

FFOM Value	Definition
0	PLL stabilized—10 MHz output within specification.
1	PLL stabilizing
2	PLL unlocked (holdover)—Initially the 10 MHz output will be within specifications. However, when in holdover, the 10 MHz output will eventually drift out of specification.
3	PLL unlocked (not in holdover)—Do not use the output.

1PPS TI indicates the difference (timing shift) between the SmartClock 1 PPS and the internal GPS 1 PPS signals.

HOLD THR (holdover threshold) displays the user-entered time error value.

ACQUISITION Section of the Status Screen

ACQUISITION Line

The **ACQUISITION** line in the screen summarizes the state of the internal GPS Engine as indicated by the **Tracking**, **Not Tracking**, and **Position** areas of the screen.

If the Receiver Engine was considered to be synchronized to the GPS signal, the [*GPS 1 PPS Valid*] message will appear at the end of the **ACQUISITION** line. If the Receiver has not yet synchronized to GPS, the [*GPS 1 PPS CLK Invalid*] message will be displayed.

Tracking, Not Tracking

The **Tracking** table indicates the number of satellites the unit is tracking.

The **Not Tracking** table indicates satellites predicted to be visible that are not tracked, and all of the satellites that are assigned to a GPS Engine channel but are not currently tracked.

Health and status indicators in the tables are defined as follows:

PRN	indicates the pseudorandom noise code assigned to the satellite.
El	indicates the predicted elevation angle, from a range of 0 to 90°. The predicted elevation is derived from the almanac.
- -	indicates that the elevation angle is unknown (the almanac did not provide this data).
Az	indicates the predicted azimuth angle, from a range of 0 to 359°. The predicted azimuth angle is referenced to true north, and is derived from the almanac.
- - -	indicates that the azimuth angle is unknown (the almanac did not provide this data).
SS	indicates the strength of the signal, from a range of 0 to 255. A signal strength of 20 to 30 is a weak signal that may not be acquired by the Receiver.

The health and status indicators in the **Not Tracking** table are described as follows:

Ignore	indicates that the user has chosen to exclude this satellite from a list of satellites available for tracking.
Not OK	indicates GPS has reported that this satellite is unhealthy.
Acq	indicates the unit is attempting to acquire the satellite signal.
Acq .	indicates the unit is reading timing information from the satellite.
Acq . .	indicates the unit is reading satellite orbital information.
ELEV MASK	indicates the elevation mask angle in degrees. Satellites at or above this elevation angle are considered for tracking.
**attempting to track*	indicates that the unit is attempting to track a satellite.

Time

When you first power up the unit the time and date that is stored in the internal GPS Engine may not be the actual date. The actual time and date will be valid after one satellite has been tracked by the Receiver.

NOTE

There are two accurate ways to express time (GPS or UTC). GPS time is offset from UTC time by the number of accumulated leap seconds since midnight of January 6, 1980 UTC.

The **Time** area of the status screen provides three types of information: **Time**, **1PPS CLK**, and **ANT DLY**.

Time has four possible modes: *GPS*, *UTC*, *LOCL GPS*, and *LOCAL*.

GPS indicates current time and date collected from a satellite in GPS Time.

LOCL GPS indicates GPS Time, offset for the local time zone.

UTC indicates current time and date collected from a satellite in UTC time.

LOCAL indicates current time and date collected from a satellite offset from UTC for the local time zone.

1PPS CLK can indicate several possible advisory messages. These messages are:

Synchronized to GPS Time	1 PPS locked to GPS, referenced to GPS Time.
Synchronized To UTC	1 PPS locked to GPS, referenced to UTC.
Assessing stability ...	applying hysteresis to locked 1 PPS signal.
Inaccurate, not tracking	not tracking satellites.
Inaccurate, inacc position	in survey mode, but has not yet calculated a position.
Absent or freq incorrect	no 1 PPS signal; or the internal GPS Engine is idle.

ANT DLY (antenna delay) displays the user-entered value that is used to compensate for the propagation delay of the antenna cable.

Position

Position area of the status screen provides four types of information: **MODE** (hold or survey), **LAT** (latitude), **LON** (longitude), and **HGT** (height).

MODE indicates whether the unit is set to Hold or Survey position mode.

When *Hold* is displayed, the unit's antenna position has been provided by the user, or the average position has been found after completion of survey.

If the unit is in the position *Hold* mode, the **LAT**, **LON**, and **HGT** "held" position coordinates will be displayed.

If *Survey: 57.3% complete* is displayed, for example, the Receiver is set to survey mode trying to determine the position of the antenna. The % value indicates the progress of the surveying.

At the beginning of a survey (0% completion), the following "estimated" position coordinates will be displayed:

INIT LAT indicates the estimated latitude (North or South) position of the unit in degrees, minutes, and seconds.

INIT LON indicates the estimated longitude (East or West) position of the unit in degrees, minutes, and seconds.

INIT HGT indicates estimated height of the unit's antenna, in meters above mean sea level (MSL).

Once survey starts, the following "averaged" position coordinates will be displayed:

AVG LAT indicates the average latitude (North or South) position of the unit in degrees, minutes, and seconds.

AVG LON indicates the average longitude (East or West) position of the unit in degrees, minutes, and seconds.

AVG HGT indicates average height of the unit's antenna, in meters above mean sea level (MSL).

The possible advisory messages that can be displayed when position mode is Survey are:

Suspended: track <4 sats

Suspended: poor geometry

Suspended: no track data

HEALTH MONITOR Section of the Screen

The HEALTH MONITOR section of the status screen reports errors or failures of the key hardware functions. The *OK* summary message at the end of the **HEALTH MONITOR** line indicates that no errors or failures were detected. *Error* indicates that one or more hardware tests failed.

For each hardware function, *OK* is reported when it is operating normally; *Err* is displayed when a failure or an error is detected.

Hardware functions are monitored periodically, with the exception of Self Test, which is performed at powerup or when requested.

The health and status indicators in the HEALTH MONITOR section are described as follows:

Self Test	Last diagnostic check of the microprocessor system, reference oscillator, satellite receiver, and power supplies failed.
Int Pwr	Internal power supply voltage(s) exceeds tolerance.
Oven Pwr	Oscillator oven power supply voltage exceeds tolerance.
OCXO	Oscillator output failed
EFC	Oscillator control voltage is at or near full-scale.
GPS Rcv	Satellite receiver communication failed, or GPS 1PPS reference is absent.

The Receiver Status Screen at a Glance

SYNCHRONIZATION

SYNCHRONIZATION *profiles the process of synchronizing time and frequency reference signals with GPS.*

HP SmartClock technology compares and adjusts (locks) the reference oscillator to GPS. In the absence of GPS, HP SmartClock operates in "holdover" mode, which maintains precise time and frequency over an extended duration by predicting and compensating for aging and temperature effects.

SmartClock Mode

Locked to GPS
Reference signals are synchronous with GPS. When `stabilizing frequency` is reported, short-term frequency errors limit the accuracy of the 10-MHz reference.

Recovery: ...
Adjusting the frequency and phase of the oscillator to correct errors accrued while in holdover operation. The phase difference between the GPS 1PPS reference and disciplined oscillator 1PPS signal is shown.

Holdover: ...
Reference outputs are not synchronous with GPS due to the reported condition. HP SmartClock maintains timing accuracy by applying learned oscillator characteristics.

`GPS 1PPS invalid`
Not tracking any satellites, or position is inaccurate

`1PPS TI exceeds hold threshold`
Phase difference between 1PPS signals exceeds a specified limit (**HOLD THR**)

`manually initiated`
User-initiated holdover.

Holdover Duration is the cumulative duration of holdover and recovery operations.

Power-up: ...
Warm-up/initial adjustment of the oscillator.

Reference Outputs

Measures of signal quality:

TFOM (Time Figure of Merit)
Accuracy of the 1PPS reference. A number between 0 (best) and 9 that denotes a timing error of 10^{TFOM-1} to 10^{TFOM} nanoseconds.

FFOM (Frequency Figure of Merit)
Frequency stability of the 10-MHz reference:
0 — Stable, signal within specification
1 — Stabilizing this signal
2 — Holdover mode; frequency will drift
3 — Signal is unusable.

1PPS TI (Time Interval)
Average phase difference between the GPS reference and oscillator 1PPS signals.

HOLD THR (Holdover Threshold)
1PPS phase difference that while exceeded forces holdover operation.

```
---------------------------- Receiver St
SYNCHRONIZATION ........................
SmartClock Mode
   Locked
>> Recovery: phase alignment [TI +1.296 us]
   Holdover
   Power-up

                  Holdover Duration: 1m 45s
ACQUISITION ............................
Tracking: 1 ____   Not Tracking: 9 _______
PRN  El  Az  SS   PRN  El  Az  PRN  El  Az
 31  75 254 168   * 2  19 313   29  Not OK
                  * 4  Acq
                  * 5  Acq .
                  * 7  -- ---
                  * 9  35 140
                   15  Ignore
                  *24  Acq ..
                  *26  47 258
ELEV MASK 10 deg  *attempting to track

HEALTH MONITOR .........................
Self Test: OK   Int Pwr: OK   Oven Pwr: OK
```

HEALTH MONITOR

HEALTH MONITOR *reports the operational status of key receiver components and internal signals.*

Self Test — Result of the last diagnostic check of the processor system, reference oscillator, satellite receiver and power supplies
Int Pwr — Internal power supplies
Oven Pwr— Oscillator oven power supply
OCXO — Oscillator 1PPS output
EFC — Oscillator frequency control voltage
GPS Rcv — Satellite receiver communication interface.

Holdover Uncertainty

Estimations of timing accuracy while in holdover mode, which reflect the extent to which HP SmartClock has learned the oscillator's characteristics:

Predict
Maximum timing error that can be expected over the initial 24 hours of holdover operation.

Present
Maximum timing error currently expected.

Trac
Sate
mus
deri
trac
sele
elev

Not
Sate
be v
pred
Trac
abo

PRN

El

Az

SS

`Acq`

`Acq`

`Acq`

`Ign`
`Not`

The Receiver Status Screen at a Glance

```
ceiver Status ----------------------------
......... [ Outputs Valid/Reduced Accuracy ]
_________ Reference Outputs ______________
          TFOM     3            FFOM     2
+1.296 us]  1PPS TI  --
          HOLD THR 1.000 us
          Holdover Uncertainty_____________
          Predict  55.8 us/initial 24 hrs
n: 1m 45s  Present  1.0 us
.......................... [ GPS 1PPS Valid ]
9 _______ Time ___________________________
N  El  Az  UTC      03:11:57    31 Jan 1996
9  Not OK  GPS 1PPS  Synchronized to UTC
          ANT DLY  120 ns
          Position _________________________
          MODE     Survey: 26.1% complete
                   Suspended: track <4 sats
          AVG LAT  N  37:19:31.797
          AVG LON  W 121:59:52.018
 track    AVG HGT            60.52 m  (MSL)

.......................................... [ OK ]
n Pwr: OK  OCXO: OK  EFC: OK  GPS Rcv: OK
```

Tracking

Satellites currently tracked by the receiver. Four or more satellites must be tracked to determine position. Timing information is derived from all tracked satellites, and is considered accurate while tracking at least one satellite from a known position. The receiver selects satellites highest in the sky that are at or above the minimum elevation angle specified by **ELEV MASK**.

Not Tracking

Satellites considered for tracking. These satellites are predicted to be visible or are selected by the "sky search" algorithm. Visibility is predicted from the satellite almanac, current time and position.

Tracking and Not Tracking tables provide supplemental information about satellite position, signal strength and health:

PRN — Identification number (pseudorandom noise code) assigned to the satellite. Satellites are sorted by ascending PRNs.

El — Elevation of the satellite (degrees) predicted by the almanac. "---" denotes it is unknown, such as when the satellite is not predicted to be visible but is selected for tracking by the sky search algorithm.

Az — Azimuth of the satellite (degrees), referenced to true north, predicted by the almanac; "---" if unknown.

SS — Relative signal strength, proportional to the signal-to-noise ratio of the received signal. The maximum value is 255; 20 to 30 is the minimum range for stable tracking.

`Acq` — Locking code and carrier tracking loops to initially acquire the satellite signal.

`Acq .` — Demodulating the satellite broadcast (NAV) message, and determining current time.

`Acq ..` — Reading the satellite ephemeris (orbital information) from the NAV message.

`Ignore` — The satellite is excluded from the selection process.

`Not OK` — GPS or Time RAIM reports the satellite is unhealthy.

ACQUISITION

ACQUISITION *profiles the process of acquiring precise time from GPS. GPS provides time-of-day information and a 1PPS reference signal used to discipline the internal oscillator.*

Time

Time of day:

UTC — Coordinated Universal Time
LOCAL — UTC with local time zone offset
GPS — GPS Time
LOCL GPS — GPS Time, with time zone offset.

[?] identifies a default power-up setting that is corrected when the first satellite is tracked.

`+1` (or `-1`) `leap second pending` is reported if a leap second correction to UTC is pending.

GPS 1PPS indicates the validity of the GPS 1PPS reference:

`Synchronized to UTC` (or `GPS Time`)
— 1PPS reference is synchronous with GPS

`Questionable accuracy...`
`Assessing stability...`
— 1PPS must be accurate for 35 seconds

`Inaccurate: not tracking`
— One or more satellites must be tracked

`Inaccurate: inacc position`
— Postition must be known to derive time

`Inaccurate: Time RAIM err`
— GPS timing integrity is suspect.

ANT DLY offsets the GPS 1PPS reference to compensate for signal propagation delays introduced by the antenna system. (Time is referenced to the position of the antenna.)

Position

An accurate position is necessary to transfer time from GPS. Two position **MODE**s are provided, hold and survey.

In `Hold` mode, a fixed position is used to derive time. This position may be specified if known, or determined by the survey process.

In `Survey` mode, position is determined from GPS. Four or more satellites must be tracked. Successive positional estimates (pseudoranges) are refined to obtain the true position, which is entered as the held position at the completion of this process.

Averaged (`AVG`) position coordinates and progress are reported while surveying. When surveying is suspended, an advisory message describes the reason:

`Suspended: track <4 sats`
— Four or more satellites must be tracked to determine position

`Suspended: poor geometry`
— DOP (dilution of precision) is too large for an accurate pseudo-range measurement.

Specifying an approximate initial (`INIT`) position will reduce satellite acquisition time.

4

Command Listing and Status Information

Chapter Contents

This chapter provides a description of each command that can be used to operate the Z3801A GPS Receiver.

This chapter is organized as follows:

- Z3801A Commands page 4-3
  - SCPI Conformance Information page 4-3
  - SCPI Syntax Conventions page 4-3
  - Description of Commands page 4-3
  - Detailed Description of the Two Time Code Formats page 4-12
- Status Information page 4-14
  - Standard Event Register Bit Assignments page 4-14
  - Questionable Status Register Bit Assignments page 4-15
  - Operation Status Register Bit Assignments page 4-15
  - Powerup Status Register Bit Assignments page 4-16
  - Holdover Status Register Bit Assignments page 4-16
  - Hardware Status Register Bit Assignments page 4-17
- Information that Appears in the Diagnostic Log page 4-18
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- Error Messages page 4-21

Z3801A Commands

SCPI Conformance Information

The Standard Commands for Programmable Instruments (SCPI) commands used in the Z3801A are in conformance with the SCPI Standard Version 1994.0.

SCPI Syntax Conventions

[ ]	An element inside brackets is optional. Note, the brackets are NOT part of the command and should NOT be sent to the Receiver.
1 | 2	Means use either 1 or 2.
<numeric_value>	Means enter a number.
SENSe	Means you MUST use either all the upper case letters or the entire word. The lower case letters are optional. For example, SENS and SENSE are both valid. However, SEN is not valid. (Note, SENSe is used here as an example, but this convention is true for all SCPI commands.) In other words, the short form of the keywords is shown in uppercase.
<n>	the notation <n> ending a command keyword indicates a numeric suffix, used to differentiate multiple instances of the same structure. The numeric suffix is applied to both the short and long forms. The valid range for the value n is specified from an enumerated list, for example [1|2|3], or from a range, for example [1..3] to indicate any of the integers from 1 to 3.

NOTE

When you see quotation marks in the command's parameter you must send the quotation marks with the command.

Description of Commands

Two command tables are provided:

- Table 4-1, which lists the "INSTALL" language commands (used to download firmware).
- Table 4-2, which lists the "PRIMARY" language commands (used for normal instrument operation).

Refer to the *58503B/59551A GPS Receivers Operating and Programming Guide* (58503-90013) for detailed descriptions of commands listed in tables 4-1 and 4-2.

Table 4-1. Z3801A INSTALL Commands

Keyword/Syntax	Parameters/ Responses	Comments
*CLS		Clear errors.
*IDN?	returns unquoted string	Identify revision of download control firmware.
DIAGnostic		Node Only. "INSTALL" language is used for downloading firmware.
:DOWNload	<Motorola® S_Record>	Send down a Motorola S-Record.
:ERASe		Erase Flash.
:SYSTem		Node Only.
:ERRor?	returns INT, quoted string	first parameter is error number, quoted string is error description.
:LANGuage	"PRIMARY" | "INSTALL"	Use "PRIMARY" to switch to normal operation commands.

Table 4-2. Z3801A PRIMARY Commands

Keyword/Syntax	Parameters/ Responses	Comments
*CLS		Clears event status registers and error queue.
*ESE	<mask value>	Sets or returns standard event status enable register.
*ESR?	returns register value	Returns and clears standard event status register.
*IDN?	returns unquoted string	Returns identification string.
*SRE	<mask value>	Sets or returns service request enable register.
*STB?	returns INTEGER	Returns the value of the Status Byte.
*TST?	returns INTEGER	Runs self tests. 0 = passed, non-zero is test specific code.

Table 4-2. Z3801A PRIMARY Commands (continued)

Keyword/Syntax	Parameters/ Responses	Comments
:DIAGnostic		Node Only
:IDENtification		Node Only.
:GPSystem?	returns a sequence of quoted strings	Returns the model number, serial number, and revision of the internal GPS receiver.
:LIFetime		Node Only.
:COUNt?	returns 32-bit integer	Returns lifetime count, indicating total powered on time.
:LOG		Node Only. See list of log messages later in this document.
:CLEar	[<log count>]	Clears the log. The optional log count parameter is provided to ensure that no log entries are unread at the time of the clear. If value sent in doesn't match current log entry count (Use :DIAG:LOG:COUNt? to obtain this number.), the clear will not take place.
:COUNt?	returns INTEGER	Identifies number of entries in log.
[:READ]? [<numeric>]	send: [<numeric>] returns: quoted string	Outputs single log entry. Optional numeric parameter can be used to identify a specific log entry. If no numeric is provided, will output most recent log entry.
:ROSCillator		Node Only.
:EFControl		Node Only.
[:RELative]?	returns INTEGER in %	Outputs EFC value in %, range -100% to +100%. Note :DIAG:ROSC:EFC? will give same response.
:QUERY		Node Only
:RESPonse?	returns unquoted string	Queries the last response item. Used when transmission error has occurred.
:LED		Node Only
:ACTive	0 | OFF | 1 | ON	Sets or queries Active LED.
:ALARm?	returns 0 | 1	Query Alarm LED. Conditions for enabling alarm are determined via :LED:ALARm:USER.
:USER	0 | OFF | 1 | ON	Provides a way to directly set Alarm.
:ENABled	0 | OFF | 1 | ON	Sets or queries Enabled LED.
:GPSLock?	returns 0 | 1	Queries Lock LED.
:HOLDover?	returns 0 | 1	Queries Holdover LED.

Table 4-2. Z3801A PRIMARY Commands (continued)

Keyword/Syntax	Parameters/ Responses	Comments
[SOURce]:PTIMe		Node Only
:FFOMerit?	returns INT	Frequency figure of merit. Generates an error (**–230, Data corrupt or stale**) when this value is unavailable.
:GPSystem		Node Only
:ADELay	<numeric in seconds>	Sets antenna delay in seconds. *Caution: use of this command while Receiver is in normal locked operation can cause jump to holdover.*
:EMANgle	<numeric in deg>	Sets elevation mask angle in degrees. 90 is straight up.
:INITial		Node Only. By setting all of the commands in this group, faster initial GPS acquisition may occur. Receiver uses initial date, time, position with almanac to predict which satellite should be visible. Note that time and position only have to be approximate for this to speed up acquisition. Acquisition will still occur even if these commands are not used.
:DATE	<yr>,<mo>,<day>	Use to speed up tracking of first satellite. Not queryable.
:TIME	<hr>,<min>,<sec>	Use to speed up tracking of first satellite. Not queryable.
:POSition	<location>	Use to speed up tracking of first satellite. <location> = N I S, <deg>, <min>, <sec>,EIW,<deg>,<min>,<sec>,<elevation in m (mean sea level). Not queryable.
:POSition	send: <location> I SURVey I LAST returns: <location>	Places Receiver in position-hold mode at this location. See above for <location> definition. SURV means to use current survey location estimate, LAST means use last position-hold value. During survey, query returns current survey location estimate.
:HOLD		Node Only
:LAST?	returns location (see definition with :GPS:INIT:POSition)	Identifies last hold position. This can be used if the Receiver has been commanded to survey but is making no progress. This query returns the last location.

Table 4-2. Z3801A PRIMARY Commands (continued)

Keyword/Syntax	Parameters/ Responses	Comments
[SOURce]:PTIMe (Cont.)		
:GPSystem (Cont.)		
:POSition (Cont.)		
:SURVey (Cont.)		Node Only
:PROGress?	returns INT in %	During survey, provides % completed (from survey start until automatic transition to position hold).
[:STATe]	send: ONCE returns: ONCE I 0	Specify ONCE to survey position. When position hold mode is attained, 0 is returned when queried.
:SATellite		Node Only.
:TRACking?	returns INT, INT, ...	Returns a list of all satellites being tracked. Satellites are identified by PRN (range 1...32). 0 means no satellites being tracked.
:TRACKing		Node Only.
:COUNt?	returns INTEGER	Returns the number of satellites being tracked.
:IGNore	INT, INT, ... (one or more PRNs)	Sends or queries list of satellites (use PRN) to ignore. 0 means no satellites being ignored.
:COUNt?	returns INTEGER	Returns the number of satellites excluded from tracking.
:INCLude	INT, INT, ... (one or more PRNs)	Sends or queries for list of satellites (use PRN) to include. 0 means no satellites being included (i.e., they are all on ignore list).
:COUNt?	returns INTEGER	Returns the number of satellites considered for tracking.
:VISible		Node Only.
:PREDicted		Node Only.
:COUNt?	returns INTEGER	Returns the number of satellites that the almanac predicts are visible.
:PREDicted?	returns INT, INT, ...	Returns list of satellites (PRN) that the almanac predicts should be visible, given date, time, and location (If any of these values are incorrect, the prediction will be incorrect). 0 means no satellites are predicted to be visible.

Table 4-2. Z3801A PRIMARY Commands (continued)

Keyword/Syntax	Parameters/ Responses	Comments
[SOURce]:PTIMe (Cont.)		
:LEAPsecond		
:ACCumulated?	returns INT	Identifies accumulated time difference (in seconds) between GPS and UTC time scales.
:GPSTime?	returns INT in HEX	GPS time of next pending leapsecond.
:SYNChronization		Node Only.
:IMMediate		Used during recovery to initiate a near instantaneous alignment of GPS 1 PPS and Receiver output 1 PPS.
:TCODe:FORMat	F1 | F2	Selects or queries the format of the time code message returned by :PTIM:TCOD?
:TCODe?	returns quoted string	Provides timecode message 980 to 20 ms prior to 1 PPS of indicated time. Format is specified by :PTIM:TCOD:FORMat. Type of data provided: time in secs of next on-time edge, TFOM, leapsec data, alarm indication, and service request. See "Detailed Description of the Two Time Code Formats" on page 4-12 for complete information.
:TINTerval?	returns REAL in seconds	Returns the filtered GPS 1 PPS to internal oscillator 1 PPS interval. Generates an error (**–230, Data corrupt or stale**) when this interval is unavailable (e.g., if no GPS 1 PPS or no satellites available).
[SOURce]:ROSCillator		Node Only. (***Note: [SOURCe]:SYNChronization is an alias for [SOURCe]:ROSCillator.)***
:HOLDover		Node Only
:DURation?	returns REAL in seconds, 0 | 1	First parameter is amount of time that Receiver has been in current holdover or amount of time of last holdover, depending on holdover state. Second parameter identifies holdover state: 0 = not in holdover, 1 = in holdover.
:INITiate		Places the Receiver in holdover. It will stay there until you send :ROSC:HOLD:REC:INITiate.
:RECovery		Node Only
:INITiate		Initiates a recovery from holdover. Use this command to take the Receiver out of a manually selected holdover. It is not used to initiate holdover recovery in any other situation.

Table 4-2. Z3801A PRIMARY Commands (continued)

Keyword/Syntax	Parameters/ Responses	Comments
[SOURce]:ROSCillator (Cont.)		
:HOLDover (Cont.)		
:RECovery (Cont.)		
:LIMit		Node Only.
:IGNore		Action only. Causes transition in holdover state from waiting-to-recover to recovering when the reason this transition isn't taking place is due to the TI limit being exceeded.
:DURation		Node Only.
:THReshold	send: <numeric> [s] returns: INTEGER	Sets the duration (in seconds) that should be used as a limit each time holdover begins. When the receiver remains in holdover longer than this duration, the EXCeed state will change (see next command).
:EXCeeded?	returns 0 | 1	Returns 1 when the duration of holdover operation exceeds the threshold set by :ROSC:HOLD:DUR:THReshold.
:LIMit		Node Only.
:THReshold	<numeric in seconds>	Sets the time interval limit (in seconds) which, if exceeded for some duration, will cause a transition from locked to holdover.
:TUNCertainty		Node Only.
:PREDicted?	returns REAL in seconds	Returns an estimate of the time error that can be expected for a 1 day holdover, given the current state of SmartClock learning in the Receiver.
:PRESent?	returns REAL in seconds	Returns the present timing uncertainty while in holdover operation.
:WAITing?	returns HARDware | GPS | LIMit | NONE	Returns prioritized reason why Receiver is waiting to recover: HARD means there is an internal hardware reason, GPS means there are no satellites, LIM means the TI between GPS and internal oscillator is exceeding the limit. NONE means it isn't waiting to recover.
[:STATe]?	OTH, or HOLD, or WAIT, or REC, or LOCK, or POW.	OTH indicates in diagnostic mode or temporary start-up mode; HOLD indicates in manual holdover mode; WAIT indicates waiting for external conditions to allow recovery from holdover; LOCK indicates locked to GPS; POW indicates in power-up prior to first lock.

Table 4-2. Z3801A PRIMARY Commands (continued)

Keyword/Syntax	Parameters/ Responses	Comments
:STATus		Node Only.
:OPERation		Node Only.
:CONDition?	returns register value	
:ENABle	<mask value>	
[:EVENt]?	returns register value	
:HARDware		Node Only. (See table in "Status Information" starting on page 4-14 for bit assignments.)
:CONDition?	returns register value	
:ENABle	<mask value>	
[:EVENt]?	returns register value	
:NTRansition	<filter value>	
:PTRansition	<filter value>	
:HOLDover		Node Only. (See table in "Status Information" starting on page 4-14 for bit assignments.)
:CONDition?	returns register value	
:ENABle	<mask value>	
[:EVENt]?	returns register value	
:NTRansition	<filter value>	
:PTRansition	<filter value>	
:NTRansition	<filter value>	
:POWerup		Node Only. (See table in "Status Information" starting on page 4-14 for bit assignments.)
:CONDition?	returns register value	
:ENABle	<mask value>	
[:EVENt]?	returns register value	
:NTRansition	<filter value>	____
:PTRansition	<filter value>	____
:PTRansition	<filter value>	____

Table 4-2. Z3801A PRIMARY Commands (continued)

Keyword/Syntax	Parameters/ Responses	Comments
:STATus (Cont.)		Node Only
:PRESet		
:ALARm		Presets the status/alarm reporting system to generate an alarm when one or more factory-default operating conditions occurs. These conditions are also retored by :SYST:PRESet.
:QUEStionable		Node Only. (See table in "Status Information" starting on page 4-14 for bit assignments.)
:CONDition?	returns register value	____
:USER	CLEar I SET	User-controlled condition for questionable register. When SET, Alarm LED will light. See Questionable register assignments below.
:ENABle	<mask value>	____
[:EVENt]?	returns register value	____
:NTRansition	<filter value>	____
:PTRansition	<filter value>	____
:SYSTem		Node Only
:ERRor?	returns INT, quoted string	The first parameter is error number, quoted string is error description.
:LANGuage	"PRIMARY" I "INSTALL"	Select "INSTALL" for firmware download.
:PRESet		Returns Receiver parameters to factory settings.
:STATus?	returns ASCII	Outputs a fully formatted status screen.

Detailed Description of the Two Time Code Formats

The :PTIMe:TCODe? time code query returns an ASCII string that begins with "T1" or "T2" followed by the time of the next 1 PPS pulse, measures of the accuracy and stability of reference signals, and service-request status.

The syntax and content of these messages are (*Note that spaces are inserted here for clarity; there are no embedded spaces in the actual message.)*:

T1 #Hxxxxxxxx	t f l r v cc <cr><lf>	(19 characters, excluding <cr><lf>)
T2 yyyymmddhhmmss	t f l r v cc <cr><lf>	(23 characters, excluding <cr><lf>)

where (see next page for description of each item in the format):

T1 or T2	is a literal, two-character header that identifies the format of the message.
[T1 format]	
#H	is a literal, two-character prefix of the unsigned hexadecimal number that follows.
xxxxxxxx	is the date and time of the next 1 PPS pulse, referenced to GPS Time, expressed as the number of seconds that have elapsed since January 6, 1980.
[T2 format]	
yyyymmdd	is the date of the next 1 PPS pulse, referenced to UTC or local time, expressed in year (yyyy)/month (mm)/day (dd) format.
hhmmss	is the time of the next 1 PPS pulse, referenced to UTC or local time, expressed in hour (hh)/minute (mm)/second (ss) format.
t	is the Time Figure of Merit, a measure of the accuracy of the 1 PPS pulse.
f	is the Frequency Figure of Merit, a measure of the stability of the 10 MHz signal.
l	is the status of a pending leap second adjustment: 0 (no adjustment pending), or + (a positive adjustment is pending), or – (a negative adjustment is pending).
r	is the request-for-service summary bit of the Status Byte Register.
v	is the validity of time-related information in this message: 0 (valid) or 1 (invalid).
cc	is the checksum of all preceding characters, computed as the sum of their ASCII-encoded values, and reported as a two-digit, ASCII-encoded hexadecimal number.

Use the :PTIMe:TCODe:FORMat <format> command to change the format of this message:

:PTIMe:TCODe:FORMat F1 — to select "T1"

:PTIMe:TCODe:FORMat F2 — to select "T2"

:PTIMe:TCODe:FORMat? queries the current setting. It returns an ASCII string, either "F1" or "F2".

T1 is the default time code format.

Status Information

Listed below are the specific bit assignments for the status registers that have assignments that are customized by the timing Receiver. See Figure 4-1 for a simplified illustration of the relationships between the Status Registers.

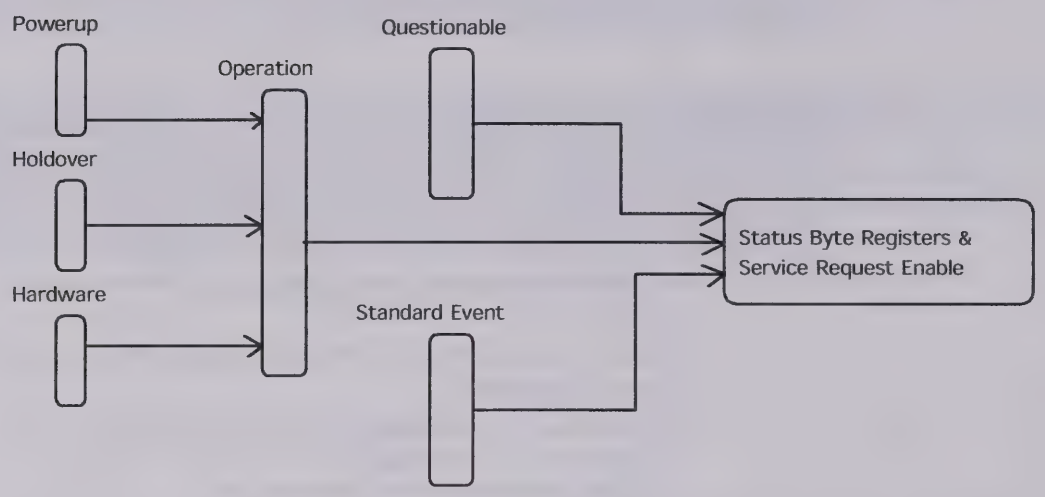

Figure 4-1. Simplified Relationships Between Status Registers

Standard Event Register Bit Assignments

Bit	Information Reported	Comments
0	Not Used	____
1	Not Used	____
2	Not Used	____
3	Device-dependent Error	These are errors in the -3xx range or any positive numbered errors.
4	Execution Error	These are errors in the -2xx range.
5	Command Error	These are errors in the -1xx range.
6	Not Used	____
7	Power-On	Identifies that the unit has undergone a transition to power-on (useful for detecting if power has been lost).

Questionable Status Register Bit Assignments

P = Positive Transition
N = Negative Transition
E = Enable
A = Alarm LED

Bit	Information Reported	Comments	P	N	E	A
0	Time has been set. Event only	This could occur after an extensive holdover period. When GPS is re-acquired, if receiver time differs from GPS time, this bit will be set.	_	_	1	1
1	User-reported	____	0	0	0	0

Operation Status Register Bit Assignments

P = Positive Transition
N = Negative Transition
E = Enable
A = Alarm LED

Bit	Information Reported	Comments	P	N	E	A
0	Powerup operation summary	Summary of powerup status register	1	0	0	0
1	Locked operation	Condition = 1 if locked to GPS, 0 otherwise.	1	0	0	0
2	Holdover operation summary	Summary of holdover status register.	1	0	1	1
3	Position hold operation	Condition = 1 if in position-hold mode, 0 if in survey mode.	1	0	0	0
4	Sufficient satellites to allow lock to GPS	Condition = 1 indicates current satellite tracking allows for locking.	1	0	0	0
5	Hardware status summary	Summary of hardware status register.	1	0	1	1
6	Log almost full	Condition = 1 indicates that the diagnostic log is nearly full (you may want to read and clear it)	1	0	0	0

Powerup Status Register Bit Assignments

P = Positive Transition
N = Negative Transition
E = Enable
A = Alarm LED

Bit	Information Reported	Comments	P	N	E	A
0	First satellite tracked	Condition = 1 when first satellite becomes tracked following powerup.	1	0	1	0
1	Oscillator oven warmed up	This bit sets when the internal oscillator has warmed up following powerup.	1	0	1	0
2	Date & Time Valid	This bit sets when first lock is attained after powerup.	1	0	1	0

Holdover Status Register Bit Assignments

P = Positive Transition
N = Negative Transition
E = Enable
A = Alarm LED

Bit	Information Reported	Comments	P	N	E	A
0	Holding	Condition = 1 if in holdover and holding.	1	0	0	0
1	Waiting	Condition = 1 if in holdover and waiting to recover.	1	0	0	0
2	Recovering	Condition = 1 if in holdover and recovering.	1	0	0	0
3	User-specified threshold exceeded	Condition = 1 if in holdover longer than value set by :ROSC:HOLD:DUR:THReshold.	1	0	1	1

Hardware Status Register Bit Assignments

P = Positive Transition
N = Negative Transition
E = Enable
A = Alarm LED

Bit	Information Reported	Comments (NOTE: For every bit in this register, STAT:PRES or SYST:PRES will cause an alarm to be generated if the bit sets)	P	N	E	A
0	Selftest failure.	Sets if something failed during powerup or user-initiated selftest.	1	0	1	1
1	+15V supply out of range	Continually evaluated during normal operation. Sets if detected.	1	0	1	1
2	-15V supply out of range	Continually evaluated during normal operation. Sets if detected.	1	0	1	1
3	+5V supply out of range	Continually evaluated during normal operation. Sets if detected.	1	0	1	1
4	Primary oven voltage out of range	Continually evaluated during normal operation. Sets if detected.	1	0	1	1
5	Secondary oven voltage out or range	Continually evaluated during normal operation. Sets if detected.	1	0	1	1
6	EFC voltage within 5% of limit	Continually evaluated during normal operation. Sets if detected.	1	0	1	1
7	EFC voltage at limit	Continually evaluated during normal operation. Sets if detected.	1	0	1	1
8	GPS 1 PPS failure	Continually evaluated during normal operation. Sets if detected.	1	0	1	1
9	GPS Failure	Continually evaluated during normal operation. Sets if detected.	1	0	1	1
10	Time Interval Errors have occurred. This is an event only. (There is no condition information; condition bit will always be 0.)	Continually evaluated during normal operation. Sets if detected. Event only (i.e., condition bit doesn't change).	_	_	1	1
11	EEPROM write failure. This is an event only. (There is no condition information; condition bit will always be 0.)	Sets if there is a failure in any attempt to save information to non-volatile memory	_	_	1	1
12	Internal Reference Failure	Continually evaluated during normal operation. Sets if detected.	1	0	1	1

Information that Appears in the Diagnostic Log

Significant events are logged by the timing Receiver. Each entry contains a brief description of the event and a time of occurrence. See the DIAG:LOG command node for commands that allow control and retrieval of logged information. Listed below are the possible log messages:

Log Message	Comments
Log cleared	Always becomes first log message when the log is cleared. See :DIAG:LOG:CLEar.
Power on	Indicates Receiver has been powered on.
Re-boot	Indicates Receiver processor has re-booted.
Survey mode started	Indicates beginning of survey for position.
Position hold mode started	Indicates transition from survey to position hold.
GPS lock started	Indicates transition into locked operation.
Holdover started, manual	Indicates transition to holdover based on user-request. See :ROSC:HOLD:INITiate.
Holdover started, GPS	Indicates transition to holdover due to GPS satellite conditions (e.g., loss of satellite) or gross problem with GPS 1 PPS.
Holdover started, TI error	Indicates transition to holdover due to problem detected with Receiver ability to properly measure interval between GPS 1 PPS and internal oscillator's 1 PPS.
Holdover started, TI limit exceeded	Indicates transition to holdover due to the interval from GPS 1 PPS to internal oscillator's 1 PPS exceeding a limit threshold for numerous measurements. See :ROSC:HOLD:LIM:THReshold.
Holdover started	Indicates transition to holdover for any reason not covered above.
SYST:PRES performed	Indicates that the instrument has been preset to factory settings.
System preset	indicates that the instrument has been preset to factory settings.
EEPROM save failed	Indicates that an attempt to save information to the EEPROM has failed.

Model for Powerup, Locked, and Holdover States

Figure 4-2 provides a model for thinking about the relationships between powerup, locked, and holdover operation of the Receiver. This model is consistent with commands that allow these states to be evaluated (e.g., see :ROSC:STATe?). Three of the states are part of holdover operation. If the Receiver is in any of these states, the holdover LED will be lit:

- *Holding* means that the Receiver has been placed in holdover by the user. An explicit command will be required to initiate an exit from holdover.
- *Waiting to recover* means that the Receiver is waiting for conditions that are needed to allow the process of recovery from holdover to begin. Once these conditions are met, the Receiver will transition on its own to the Recovering state.
- *Recovering* means that the Receiver is actively working to become locked. All conditions needed to proceed toward locked have been met. Expect an eventual spontaneous transition to *locked* (unless external conditions change to prevent this, such as loss of tracked satellites).

The other two states are:

- *Powerup*, indicating that the Receiver hasn't yet achieved GPS lock since it's been powered on. Other queries can provide insight as to the cause if the Receiver is remaining in powerup longer than expected.
- *Locked*, meaning that the Receiver is locked to GPS. The locked LED will be lit.

Commands that can be used to transition between states are shown in Figure 4-2.

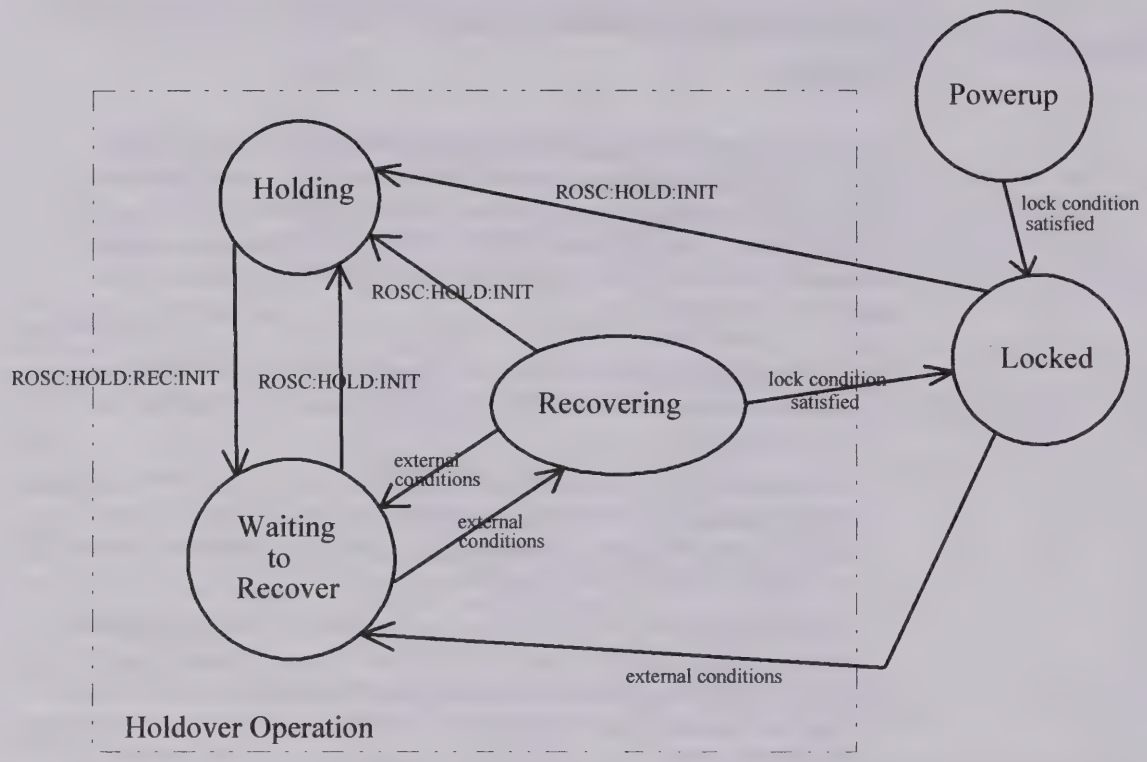

Figure 4-2. Model of Relationships Between Powerup, Locked, and Holdover Operation of the Receiver

Error Messages

Number	Error String	Cause
+0	No Error	The error queue is empty. Every error in the queue has been read (:SYSTem:ERRor? query) or the queue was cleared by power-on or *CLS.
-100	Command error	This is the generic syntax error used if the Receiver cannot detect more specific errors.
-101	Invalid character	A syntactic element contains a character that is invalid for that type.
-102	Syntax error	An unrecognized command or data type was encountered.
-103	Invalid separator	The parser was expecting a separator and encountered an illegal character.
-104	Data type error	The parser recognized a data element different than the one allowed. For example, numeric or string data was expected, but block data was received.
-108	Parameter not allowed	More parameters were received than expected for the header.
-109	Missing parameter	Fewer parameters were received than required for the header.
-112	Program mnemonic too long	The header or character data element contains more than twelve characters.
-113	Undefined header	The header is undefined. For example, the command ":HELLO".
-120	Numeric data error	This error, as well as errors -121 through -129, is generated when parsing a data element which appears to be numeric. This particular error message is used when the Receiver cannot detect a more specific error.
-121	Invalid character in number	An invalid character for the data type being parsed was encountered. For example, a "9" in octal data.
-123	Exponent too large	Numeric overflow.
-124	Too many digits	The mantissa of a decimal numeric data element contained more than 255 digits excluding leading zeros.
-128	Numeric data not allowed	A legal numeric data element was received, but the Receiver does not accept one in this position for the header.
-131	Invalid suffix	The suffix does not follow the syntax described in IEEE 488.2 or the suffix is inappropriate for the Receiver.
-134	Suffix too long	The suffix contained more than 12 characters.
-138	Suffix not allowed	A suffix was encounterd after a numeric element that does not allow a suffix.

Number	Error String	Cause
-141	Invalid character data	The character data element contains an invalid character.
-148	Character data not allowed	A legal character data element was encountered where prohibited by the Receiver.
-150	String data error	This error can be generated when parsing a string data element. This particular error message is used if the Receiver cannot detect a more specific error.
-151	Invalid string data	A string data element was expected but was invalid for some reason.
-158	String data not allowed	A string data element was encountered but was not allowed by the Receiver at this point in parsing.
-170	Expression error	This error can be generated when parsing an expression data element. It is used if the Receiver cannot detect a more specific error.
-178	Expression data not allowed	Expression data was encountered but was not allowed by the Receiver at this point in parsing.
-200	Execution error	This is the generic syntax error if the Receiver cannot detect more specific errors.
-220	Parameter error	Indicates that a program data element error occurred. This error is used when the Receiver cannot detect more specific errors.
-221	Settings conflict	Indicates that a legal program data element was parsed but cound not be executed due to the current receiver state.
-222	Data out of range	Indicates that a legal program data element was parsed but could not be executed because the interpreted value is outside the legal range defined by the Receiver.
-223	Too much data	Indicates that a legal program data element of block, expression, or string type was received that contained more data than the Receiver could handle due to memory or related receiver-specific requirements.
-224	Illegal parameter value	Used where exact value, from a list of possible values, was expected (but not received).
-230	Data corrupt or stale	No valid data available.
-240	Hardware error	Indicates that a legal program command or query could not be executed because of a hardware problem in the Receiver.
-241	Hardware missing	Indicates that a legal program command or query could not be executed because of missing receiver hardware.
-300	Device-specific error	This is the generic device-dependent error.
-310	System error	Indicates that a system error occurred.
-321	Out of memory	Indicates that the Receiver has detected that insufficient memory is available.

Number	Error String	Cause
-330	Self-test failed	Indicates at least one failure occurred when *TST? or :DIAG:TEST? was executed.
-360	Communication error	This is the generic communication error for devices that cannot detect the more specific errors described for errors -361 through -363.
-361	Parity error in program message	Parity bit not correct when data received.
-362	Framing error in program message	A stop bit was not detected when data was received.
-363	Input buffer overrun	Software or hardware input buffer on serial port overflows with data caused by improper or nonexistent pacing.
+521	EEPROM failed	An attempt to write to EEPROM failed.

5

Specifications Summary

Specifications and Characteristics

The specifications and characteristics of the Z3801A GPS Time and Frequency Reference Receiver are provided in this chapter.

GPS Receiver Features

Six-channel, parallel tracking GPS engine
C/A Code, L1 Carrier
SmartClock™ technology
Enhanced GPS technology

10 MHz Output Characteristics

Frequency Accuracy: $< 1 \times 10^{-9}$, one day average

Phase Noise:

Offset (Hz)	SSB Phase Noise (dBc)
100	-120
1000	-135
10000	-135

J2

Waveform: Sine wave, 1.9 Vp-p into a 50Ω load (typical)

Source Impedance (nominal): 50Ω

Coupling: AC

Connector: BNC

NOTE

Complete product specifications are defined by Qualcomm CDMA Land Network Specification 80-12225.

1 PPS Output Characteristics

Jitter of leading edge: < 200 nanoseconds between pulses.

Accumulated time error: < 7 microseconds per day unlocked, for 24 hours, after one day of stabilization and 2 days of locked operation with a fixed antenna location.

Waveform: Pulse width 10 to 50 microseconds.

Time Accuracy: < 1 microsecond (Locked to GPS)

Connector: DB-25 (J3)

Front Panel Indicators (LEDs)

Power (Z3801A has power applied)

Enabled, Active (user-defined operation)

GPS Lock (Z3801A is locked to GPS)

Holdover (Z3801A is operating in holdover mode)

Alarm (indicates an alarm condition)

Remote Interface (Port 1)

RS-422 DTE configuration: Complete remote control and interrogation of all instrument functions and parameters.

Baud Rate: 19200—7 data bits, 1 start bit, 1 stop bit, odd parity (fixed configuration).

Connectors: 25-pin female rectangular D subminiature (DB-25) on rear panel.

Antenna and Cabling Information

The 58504A Antenna Assembly is recommended to ensure specified performance.

Power Requirements (supplied by the Z3801A): 5 Volts nominal; 50 ma maximum.

Antenna Cable: 200 feet Cables are Belden 9913 with a type N connector one end and a type TNC connector on the other.

Environmental

58504A Antenna Assembly

Operating: -40° C to +80° C

Storage: -40° C to +85° C

GPS Time and Frequency Reference Receiver

Operating: 0° C to +50° C

Storage: -40° C to +80° C

Power Requirements

DC Power:

BTS; +27 Vdc nominal (19 Vdc ± 0.5 Vdc to 30 Vdc ± 0.5 Vdc operating range). Greater than 23 Vdc ± 0.5 Vdc starting.

BSC; -54 Vdc nominal (-60 Vdc ± 0.5 Vdc to -37 Vdc ± 0.5 Vdc operating range). Less than -46 Vdc ± 0.5 Vdc starting.

Input Power (BTS and BSC): < 25 Watts (nominal)

General Information

Dimensions: 127 mm Height × 301.5 mm Width × 345.4 mm Depth. (Half-Rack Module)

Weight: 3.6 kg

Acceleration: 2g

Power: < 25 Watts

Surge withstand: Meets IEEE/ANSI C37.90, C37.90.1, C37.90.2

Other Information

The standard Z3801A does not include a display or a keypad. While not necessary, it may be convenient to track the Receiver's progress during installation and startup by monitoring the satellites being tracked, location (position), time and other parameters.

Achieving accurate time of day requires care in determining cable delays, Receiver bias, position (Lat, Lon, Alt), atmospheric conditions, and other parameters which are dependent on each individual installation.

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